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SEPTEMBER 9, 10, 11, 12, 1942

HOTEL WILLIAM PENN

PITTSBURGH, PA.

Volume XXIII

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No. 4

21st Annual Scientific and Clinical Session

AMERICAN CONGRESS of PHYSICAL THERAPY

September 9, 10, 11, 12, 1942

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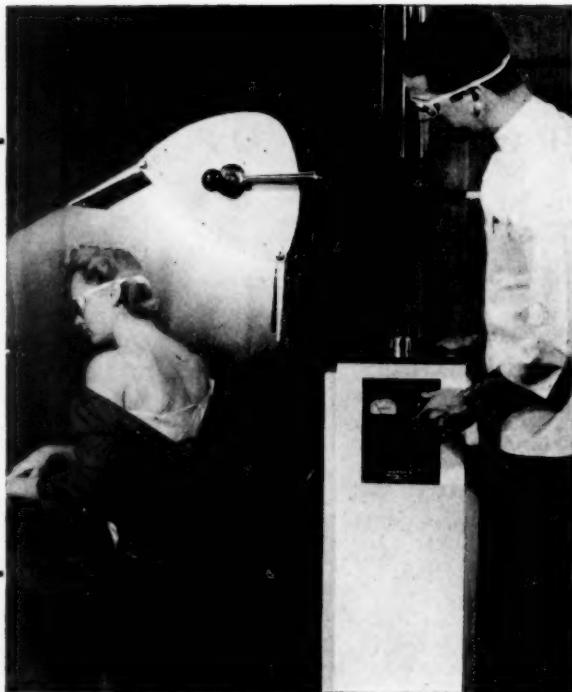
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ARTIFICIAL FEVER THERAPY *

A Discussion of Its Management and a Report of the Complications of 6,881 Treatments

J. A. TRAUTMAN, Passed Assistant Surgeon

United States Public Health Service

During the past few years the management of artificial fever therapy as induced in fever cabinets has been vastly improved owing to the efforts of many investigators who have unceasingly studied the various phases of this valuable therapeutic procedure. As a result fever treatment may now be given with relative safety and ease, providing that certain basic principles are followed.

For the proper and efficient management of fever therapy, it is mandatory that the department be in a recognized and well organized hospital where the necessary roentgen ray, laboratory, basal metabolic and electrocardiographic studies can be done and where proper nursing care before and after fever therapy is assured. In addition, cooperation of other departments of the hospital is required to maintain the highest standards of fever therapy.

The department should be under the immediate direction of a physician who has been well trained in all phases of the technic of fever therapy and in the proper selection of patients for such treatment. Nurse-technicians who administer the treatments should have received their training in an institution where such work has already been organized. It is advisable too that at least one nurse-technician be trained in an institution using the type of cabinet that is expected to be used in the hospital. After the department has been organized, additional nurses may be trained as the need for additional personnel develops.

It is considered necessary to have one nurse-technician for each patient and that she be in constant attendance during the entire fever session. Likewise, it is essential that a physician always be available to check the patient at intervals during the treatment and to be near by for emergency calls. We have never given fever sessions without a physician on duty in the department.

The selection of the type of fever cabinet is obviously of great importance. Since only one type of cabinet has been used in our work, we are not in a position to decide which is the best cabinet. More than one type of cabinet is acceptable, and it is suggested that physicians interested in fever therapy would do best in arriving at a proper decision by actually observing treatments administered with the different types of cabinets. For the induction of therapeutic fever we are using at present an all metal cabinet comprising the following basic units: (1) a small electric heater, (2) a humidifier and (3) a small electric fan for circulation of the warm moist air. An electric thermometer consisting of a rectal applicator and a temperature-indicating instrument is attached to the apparatus and greatly simplifies determination of the patient's temperature.

The selection of patients to be treated requires careful consideration by experienced physicians. It is the duty of these physicians to determine whether the disease or condition to be treated will respond sufficiently to warrant fever therapy and to decide whether or not the patient is capable of tolerating therapeutic fever after he has reviewed the history, physical examination, urinalyses, blood count, roentgenograms, electrocardiograms and any other studies which have been necessary. It is difficult to state specifically all the contraindications to fever therapy, but each patient has to be carefully considered as to his ability to tolerate hyperpyrexia. Physicians who have had considerable experience in

* From the Department of Fever Therapy, United States Marine Hospital, New Orleans, Louisiana.
* Assistance was given by the personnel of the Work Projects Administration.

this work are able to determine accurately the height of the fever that may be administered with safety as well as the duration and the number of the fever sessions necessary. The contraindications to fever therapy are somewhat similar to those for major operations, according to our experience, except that the requirements are generally more rigid. Specifically, we are not inclined to treat patients who have cardiovascular, renal or hepatic disease or degenerative disease of other organs. We do not like to treat the old or the very young. In our hospital only a few children have been treated because of the limited number of such patients admitted to the hospital, and only 1 of those treated was less than 10 years of age. Several patients between 50 and 63 years of age have been treated, but it is felt that the risks increase when patients over 50 are exposed to the higher levels of bodily temperature. Patients with chronic debilitating diseases do not tolerate the higher temperatures, and when treatments are necessary for these patients they should receive short fever sessions at low bodily temperatures. If the general condition improves, higher temperatures may be induced with extreme caution.

After it is decided to submit the patient to fever therapy, he is advised as to the details of the treatment, and in some cases he is taken to the treatment room for an explanation. It is best if possible to have the nurse-technician talk to the patient in order that he may acquire confidence in the person who is to give him the treatment. It requires a certain amount of courage to take fever therapy, and everything should be done to make the patient desirous of completing the necessary treatments. If the patient appears apprehensive it is advisable to give him a mild sedative the night before treatment. In the past, another pretreatment procedure consisted of giving sodium chloride orally the night before the fever treatment with the hope that this might be helpful in maintaining the chloride level of the blood during the treatment. It is questionable that this is necessary, since the chlorides can be supplied adequately by mouth or intravenously during the treatment. There is no objection, however, to giving sodium chloride the night before treatment. No food is given on the morning of the treatment. About one hour before the treatment is started the patient is given an enema. He is weighed (if possible) and the oral and the rectal temperature, the blood pressure and the pulse rate are determined immediately before the treatment. He is then placed in the preheated fever cabinet, and the bulb of the registering thermometer is inserted in the rectum. The cabinet is then closed; the patient lies in the cabinet with only his head emerging. He wears no clothing or covering except a towel over the genitalia.

To add to the safety of fever therapy, trial or pilot sessions are used in some hospitals. These treatments are given for about two hours at a temperature of 103 to 104 F. and followed the next or second day by the longer fever session indicated. As a result of the trial session the patient loses any fear he may have of the treatment, the physician is able to gage the patient's ability to tolerate treatment, the nurse-technician has an opportunity to study the patient and gain his confidence and, lastly, such a treatment apparently aids the patient in tolerating subsequent treatments by allowing him to become accommodated to a moist, hot atmosphere. At the present time the fever cabinets used are so constructed that cabinet temperatures ranging from 114 to 118 F. are adequate to induce fever with ease, at the maximum level of safety, which we consider to be not above 106.8 to 107 F. The induction period of the higher levels of bodily temperatures should not be shorter than one hour. An induction period of one hour and 30 minutes is less troublesome and creates fewer difficulties from the viewpoint of both the nurse-technician and the patient. It is during this period that apprehension and restlessness combined with fear may cause the patient to refuse to continue treatment. When the bodily temperature has reached the level desired, the cabinet temperature is lowered to a point be-

tween 108 and 114 F., the exact level depending on the height at which the patient's temperature is to be maintained and his response to the heated atmosphere.

It is necessary to maintain the fluid and chloride balance of the blood by giving an iced solution of 0.6 per cent saline chloride orally during the treatment. If oral administration of fluid is not tolerated, physiologic solution of sodium chloride is given intravenously. To combat restlessness, pantopon hydrochloricum, 1/3 grain (0.02 Gm.), is used at the beginning of the fever session, but an attempt is made to limit its use, with the result that some patients require none but the majority require one to two doses of the drug during the treatment.

The pulse rate is determined every ten minutes throughout the session, and the blood pressure should be taken when conditions warrant. Treatments are discontinued when the blood pressure remains below a systolic pressure of 80 mm. of mercury, the pulse pressure becomes less than 20 mm. of mercury, or the pulse rate is persistently over 160 per minute. The indicating rectal thermometer, being always in view, permits constant knowledge of the temperature of the patient. Tetany is usually controlled by the intravenous administration of calcium gluconate or by inhalations of carbon dioxide and oxygen. Delirium and persistent restlessness, persistent nausea and vomiting, severe abdominal pain and distention, convulsions, shock, heat stroke, pain and numbness of extremities are some of the conditions which require the attending physician to give emergency treatment or to make a decision as to whether or not the treatment is to be continued. The nurse-technician always calls for immediate assistance when such complications develop, because of the possibility that a fatal termination will result from severe reactions.

When the fever treatment is completed the bodily temperature drops to normal or near normal in about one to two hours. The drop is accomplished by removing the patient from the cabinet, directing an electric fan over him and sprinkling luke-warm water on his body. These procedures may be followed by an alcohol rub. When the patient's temperature returns to normal or near normal he is sent back to his ward. He is not discharged immediately, as it is preferred that he remain in the hospital until the next morning or longer if conditions warrant.

The basic requirements for fever therapy as presented here are those which have been adhered to in our work, but in order to present more clearly the treatment complications it is apropos that the types of patients as well as the conditions treated be also briefly mentioned. From June 1, 1934 to June 1, 1941, 1,200 patients had received a total of 6,881 fever treatments, or an average of 5.7 treatments per patient. Of these 1,200 patients, 1,180 were male and 20 were female. Their ages ranged from 4 to 63 years, the average being 29.7 years. Fever therapy was given to 653 patients with gonorrhea; 352 of these had had no previous therapy with sulfanilamide or a derivative and 313 had had such therapy before or in combination with fever therapy.

When fever therapy was first given to this series of patients, the fever sessions for gonorrhea were scheduled at intervals of seven days, but subsequently the interval was changed to two to three days. In most cases the elevation of bodily temperature was at 106 to 107 F. for five hours. The fever sessions were altered in duration as time passed, until at present a trial session is given first and is followed the next or second day with a ten hour fever session at a bodily temperature of 106 to 107 F. Usually 1 or 2 long sessions are adequate.

Three procedures were used in the administration of fever therapy to 248 patients having syphilis (179 of these had neurosyphilis): (1) five hour sessions with the bodily temperature elevated to 105 to 106 F. once or twice weekly for 10 sessions; (2) five sessions of ten hours each with elevation of the bodily

temperature to 105 to 106 F., administered once a week, and (3) three hours of fever therapy twice weekly for six weeks with elevation of the bodily temperature to 105 to 106 F. It was believed that the shorter sessions were as effective as the long sessions and less hazardous.

Ocular conditions in 57 patients, consisting principally of exudative choroiditis, iritis, keratitis, corneal ulcers, gonorrhreal ophthalmia and sympathetic ophthalmia usually were treated with fever therapy twice weekly with the bodily temperature elevated to 105 to 106 F. for five hours, with the exception that ocular conditions due to gonorrhea were treated like other gonococcic manifestations.

Fever sessions at a bodily temperature of 105 to 107 F. for five hours at intervals of two to three days were given to 7 patients who had venereal lymphogranuloma.

In a group of 127 patients having nonspecific infections such as acute urethritis and chronic urethritis, either without complications or with one or more such complications as periurethral abscess, acute prostatitis, chronic prostatitis and acute epididymitis, fever therapy was administered with the bodily temperature at 103 to 107 F. for three to five hours at intervals of two to seven days. This schedule was also applied to 28 patients with acute infectious arthritis, 42 patients with chronic infectious arthritis, 25 patients with chronic hypertrophic arthritis, 18 patients with leprosy and a miscellaneous group of 38 patients having twenty-two different diseases.

The results obtained in many of these conditions from fever therapy were satisfactory and in others very discouraging. However, the results will not be discussed at this time, since previous reports¹⁻⁸ have summarized some of our results.

The technic of fever therapy has improved greatly since 1934 owing to increased experience and newer conceptions of management. The most important change has been in the air conditions in the cabinet. Records of the first treatments given with an air-conditioned cabinet in our hospital indicate that the dry bulb temperature in the cabinet ranged from 150 to 155 F., while the relative humidity ranged from 35 to 40 per cent. This has gradually changed, until at present the temperature in the cabinet ranges from 108 to 118 F., while the relative humidity is near saturation. The circulation of the air in the cabinet is accomplished by means of a small electric fan, whereas previously an air blower of considerable force was used. These changes, together with a better understanding of physiologic effects in relation to the fluid and chloride balance of the blood, and other factors, led to safer and more comfortable treatments. To illustrate the effect of the changes in technic, the various complications that occurred in 4,609 treatments given between June 1, 1934 and Sept. 1, 1938 are compared with those in 2,272 treatments given between Sept. 1, 1938 and June 1, 1941. The first period represents roughly the developmental phase of the apparatus which was used, whereas the second period, between September, 1938 and June, 1941, represents approximately the period when the technic had reached its present degree of efficiency. Except for the addition of newer equipment, the technic and the conditions under which the treatments have been given have remained essentially unaltered since September, 1938.

Table 1 shows the number of short and of long fever sessions and the height of the temperature induced in the two groups according to the period in which the treatment was given; namely, group 1, between June 1, 1934 and Sept. 1, 1938, and group 2, between Sept. 1, 1938 and June 1, 1941.

There were numerous complications, ranging from mild to severe, which occurred during and after 6,881 fever treatments. One patient died several

TABLE 1.—*Height of Temperature, Duration of Treatment and Number of Treatments for Two Groups.*

Group 1.—June 1, 1934 to Sept. 1, 1938				Group 2.—Sept. 1, 1938 to June 1, 1941			
Duration of Sessions				Duration of Sessions			
6 to 10 Hrs.	2 to 6 Hrs.	Maintenance Level	Total Treatments	Temperature Induced, F.	6 to 10 Hrs.	2 to 6 Hrs.	Maintenance Level
86	2,136	...	2,222	106-107	381	131	...
112	1,553	...	1,665	105-106	141	888	...
10	522	...	532	104-105	28	492	...
0	163	...	163	104 or less	1	173	...
...	...	27	27	Did not reach maintenance level	...	37	37
208	4,374	27	4,609	Total	551	1,684	37
							2,272

Total for groups 1 and 2, 6,881 fever treatments.

hours after completion of a fever session. Since death from treatment is a possibility, it is of greatest importance to terminate the treatment immediately when the danger signs are present. The complications, therefore, which caused termination of treatment were very important in that a continuation of the treatment in the face of these complications might have resulted in death in some cases. Table 2 shows the number and types of complications which resulted in termination of treatment and the mortality rate in the groups 1 and 2.

TABLE 2.—*Complications of Sufficient Severity to Cause Termination of Fever Session*

	Group 1.—(800 Patients) 4,609 Treatments			Group 2.—(400 Patients) 2,272 Treatments			Total	
	105-107 F.; 3.88% Sessions	105 F. or Less; 695 Sessions	Did Not Reach Main- tenance Level; 27 Sessions	Total	105-107 F.; 1.54% Sessions	105 F. or Less; 634 Sessions	Did Not Reach Main- tenance Level; 37 Sessions	
Death resulted from treatment	1	0	0	1 (0.02%)	0	0	0	0
Persistently rapid, weak or irregular pulse; low blood pressure	56	14	2	72 (1.5%)	6	3	1	10 (0.4%)
Gradually increasing blood pressure	3	2	1	6 (0.13%)	1	2	1	4 (0.17%)
Shock	3	1	0	4 (0.08%)	1	0	0	1 (0.04%)
Delirium or extreme restlessness	16	4	1	21 (0.5%)	8	5	6	19 (0.80%)
Stupor	2	0	0	2 (0.04%)	1	0	0	1 (0.04%)
Convulsions	2	0	1	3 (0.06%)	0	0	1	1 (0.04%)
Nausea and vomiting	5	0	0	5 (0.10%)	1	1	1	3 (0.13%)
Tetany	1	3	2	6 (0.13%)	0	3	1	4 (0.17%)
Extreme weakness	2	3	0	5 (0.10%)	0	0	0	0
Severe pain in feet	0	0	1	1 (0.02%)	0	0	0	0
Headache and pain in chest	0	0	1	1 (0.02%)	0	0	0	0
Severe abdominal pain	2	0	4	6 (0.13%)	1	1	1	3 (0.13%)
Tetany and hiccup	0	1	0	1 (0.02%)	0	0	0	0
Severe back pain	1	0	0	1 (0.02%)	0	0	0	0
Severe chest pain	1	2	0	3 (0.06%)	0	0	0	0
Severe headache	0	2	1	3 (0.06%)	0	0	0	0
Aphasia	0	0	1	1 (0.02%)	0	0	0	0
Refusal to continue treatment	8	2	14	24 (0.52%)	4	2	16	22 (0.90%)
Blisters on arms	0	0	0	0	0	1	0	1 (0.04%)
Marked erythema and itching of skin	0	0	0	0	0	0	1	1 (0.04%)
Numbness of extremities	0	0	0	0	0	0	1	1 (0.04%)
Total	103	34	29	166 (3.6%)	23	18	30	71 (3.1%)

There was one death in the entire series of 6,881 fever treatments administered to 1,200 patients, or a mortality rate of 0.08 per cent.

The patient, a white man aged 27, received his first and only fever treatment on March 27, 1936. Just before the treatment began he was given 6 grains (0.36 Gm.) of sodium amytal, and during the treatment he received $\frac{1}{2}$ grain (0.03 Gm.) of morphine sulfate. He was placed in the fever cabinet at 7:20 a. m., and at 8:40 a. m. his temperature had reached 107 F. The course of the treatment was satisfactory, and the temperature was maintained at a level between 106.4 and 107 F. for five hours. Sodium chloride, 3,000 cc. of 0.6 per cent solution, was given orally during the first four hours of the treatment, but during the last hour the patient had little fluid by mouth. He received instead an intravenous injection of 500 cc. of physiologic solution of sodium chloride containing 10 per cent dextrose. No other medication was given. The blood pressure at the beginning of the treatment was 112 mm. of mercury systolic and 78 diastolic. The treatment ended at 1:40 p. m., at which time the blood pressure was 90 mm. of mercury systolic and 50 diastolic. The temperature returned to normal early in the afternoon and remained so until about 8:15 p. m., when it began to rise rapidly, and in a short time it was above 107 F. The patient became delirious and then comatose and died at 9:15 p. m.

An autopsy was performed by Dr. J. A. Lanford, consultant in pathology, and his report was as follows:

The brain was intensely congested on its entire outer surface; all the small capillaries and large venous channels were distended with blood. There was no evidence of hemorrhage under the pia.

When the brain was opened, wherever a section was made the capillaries oozed blood. There was, however, no blood in the ventricles, and when the corpus callosum and the structures beneath it were peeled back, it was found that the corpus striatum showed areas of intense congestion on the right side near the internal capsule and the anterior tip of the optic thalamus on both sides. On the right side there was an intensely congested area which was somewhat softened. When this particular area was sectioned it was noted that markedly congested areas were present throughout the entire body and particularly on the superior surface, extending downward 3 to 5 mm. Throughout the remainder of the cerebrum no marked pathologic changes were demonstrated except intense congestion. The cortex of the cerebellum had a reddish tinge, and there were areas of more intense congestion.

The heart was slightly increased in size but was relatively firm and covered with a considerable amount of epicardial fat. The right side was somewhat dilated; the left side was rather firmly contracted.

The right auricle and the right ventricle showed no evidence of disease. The right ventricular wall was firm but had somewhat lost its normal tone.

The tricuspid and the pulmonary valve were normal.

The left auricle was normal.

The foramen ovale was closed.

The left ventricle showed a large hypertrophied wall measuring from 1.8 to 2 cm. in thickness. It was brownish red, with some areas of increased connective tissue.

The heart was relatively firm throughout.

There was considerable hemorrhage beneath the endocardium of the right ventricle, as shown by a confluent mass and a few petechial hemorrhages. The papillary muscle of this part was also hemorrhagic, being intensely purplish red, but the hemorrhagic zone was entirely superficial and did not involve the musculature, being located just beneath the endocardium.

The mitral and the aortic valve were normal.

The coronary vessels were not encroached on at their orifices by thickening, nor did they show any evidence of occlusion or narrowing throughout their distribution.

The attached portion of the aorta and the aorta in general showed only slight arteriosclerotic changes of a nonspecific character.

Both lungs were somewhat decreased in size, being somewhat atelectatic. They were a peculiar pink throughout, there being relatively little pigmentation, and there was carbon pigment deposited here and there. The left lung showed some old fibrous adhesions between the lobes but was without generalized involvement. The outer surfaces generally were smooth. The right lung showed no evidence of former disease. The organs were fairly firm in consistency on sectioning and of a peculiar reddish purple. No marked amount of fluid exuded on pressure. When the bronchial tree was opened it was found to be acutely congested with reddish purple mucus. No area of pneumonia was noted. Petechial hemorrhages were seen in various regions in the epithelium of the bronchial mucosa.

The spleen was slightly increased in size, was a dark purplish color, was smooth on its external surface and was flabby. On sectioning it showed some increased pulp with demonstrable lymph follicles and no increase in connective tissue. There was no evidence of hemorrhage, but the organ was intensely congested.

The pancreas was grossly normal.

The liver was about normal in size, and the proportion between the two lobes was approximately normal. The outer surface was a dark purplish red, and beneath the capsule distended lymphatics were noted coursing over the surface. On sectioning there was no increased resistance to the knife, the cut surface being brownish red, and rather uniform in appearance, although in various regions there was some distension of the central veins, the surrounding hepatic cells being of a lighter brownish red.

The gallbladder contained a small amount of dark greenish bile. The duct was patent on pressure.

The mucosa of the stomach and the entire intestinal tract was a rather dark pinkish brown, being somewhat more congested than normal; however, no evidence of erosion or ulceration was demonstrated anywhere.

The kidneys were about normal in size and were covered with a fair amount of fat. Through the fatty capsule and the renal capsule the structure appeared intensely purplish red. On section there was no contrast between the cortex and the medulla, and they were both intensely congested and dark brownish red. The cortex, on careful inspection, was found to be slightly narrowed, measuring about 5 mm. in thickness. This together with other portions of the tubular epithelium was somewhat more translucent. There was a considerable amount of fat around the pelvis, but the epithelial lining of this organ showed no evidence of disease.

The gross appearance of the adrenals was not described.

Histologic examination gave the following results:

The small blood vessels of the basal ganglia were seen to be markedly congested, and in various regions there were areas of hemorrhage. In the cerebellum there were areas of widespread hemorrhage, with congested blood vessels everywhere, associated with edema. There were some degenerative changes demonstrable in the Purkinje's cells.

The fibers of the heart muscle were seen to be rather widely separated by serum. Some of the fibers showed pyknosis in the nuclei, and there was a small increase in connective tissue. The organ was generally edematous.

The spleen was acutely congested. There were some narrowing of the lymph follicles, an increase in pulp and areas of hemorrhage.

The pancreas showed postmortem changes.

The liver was markedly pigmented; practically every cell contained brownish pigmentation. There was some fatty degeneration, and granular changes were also noted.

The kidneys were markedly congested and considerably swollen, and there was some degeneration of the epithelium of the collecting tubules.

There was marked hydropic and parenchymatous degeneration of the adrenals, with vacuolization, especially of the cortex. There were also a few aggregations of lymphoid and plasma cells.

The seminal vesicles were normal; however, the blood vessels surrounding them showed intimal proliferation.

This sudden and unexpected death and the only one in our experience has caused us to reflect very much on the subject of extreme care and caution in the management of fever therapy not only during the session itself but before and after as well. It is our belief that in this instance, despite the fact that apparently a fair amount of salt solution was administered during the treatment, the cause of the secondary fever following the session and the basic cause of death were principally a fluid and chloride deficiency.

Additional important facts to be noted in table 2 are that the more recently treated group of patients had a marked decrease in complications involving the cardiovascular system leading to termination of the fever sessions despite the fact that many more sessions of fever with the bodily temperature elevated to 106 to 107 F. for ten hours were administered. There was an increase in the number of treatments terminated in group 2 because of delirium and restlessness, but this was due to two factors: (1) an increase in the number of long fever sessions and (2) an inclination to discontinue treatments when restlessness and delirium persisted, whereas in the first group the treatments were often continued despite these complications. The latter also applied to most other complications, including those of the cardiovascular system. Our records indicate, for example, that some patients in group 1 were permitted to complete fever sessions despite a fall of blood pressure to less than 80 mm. of mercury systolic,

a persistent pulse rate of over 160 per minute or a pulse pressure of less than 20. In accordance with our present conception of treatment such sessions would not have been completed. Convulsions and stupor, in all instances, called for immediate cessation of treatment, and patients having these complications were generally not given further fever treatment. The refusal to continue treatment was concerned mostly with two factors: (1) lack of courage on the part of the patient and (2) failure of the personnel to appreciate the problems of the patients during the fever sessions. The increase in the percentage of refusals to continue treatment in group 2 was due principally to the latter factor and called for adjustments in the personnel of the department. The remainder of the reasons for terminating treatment, as listed in table 2, are more or less self explanatory.

In addition to the complications which caused termination of treatments and one death, there were numerous other complications which did not result in termination of treatment. Table 3 showed the incidence of some of the more important and frequent complications. The complications noted in table 2 as causing termination of treatment are included in their corresponding groups in table 3.

TABLE 3.—*Incidence of Low Blood Pressure, Rapid Pulse, Restlessness, Delirium, Nausea and Vomiting.*

	Group 1.—4,609 Treatments				Group 2.—2,272 Treatments			
	105-107 F.; 3,887 Treat- ments	105 F. or less; 615 Treatments	Did Not Reach Main- tenance Level; 27 Treatments	Total 4,609	105-107 F.; 1,541 Treat- ments	105 F. or less; 684 Treatments	Did Not Reach Main- tenance Level; 37 Treatments	Total
Blood pressure, 80 systolic or below, during or after treatment (8.5%)	332	23 (3.3%)	1 (3.7%)	356 (7.7%)	28 (1.8%)	16 (2.3%)	0	44 (1.9%)
Pulse rate, over 160 per minute at some time during or af- ter treatment (12%)	465	23 (3.3%)	2 (7.4%)	490 (10.6%)	91 (5.9%)	37 (5.3%)	1 (2.7%)	129 (5.7%)
Mild restlessness (60%)	2,325	445 (64%)	6 (22.2%)	2,770 (60%)	1,045 (67%)	342 (49.2%)	9 (24.3%)	1,396 (61.5%)
Episodes of delir- ium; occasional marked restlessness. (17%)	678	46 (6.6%)	0	724 (15.7%)	89 (5.8%)	16 (2.3%)	4 (10.8%)	109 (4.8%)
Persistent restless- ness with episodes of delirium (10%)	387	22 (3.1%)	0	409 (8.8%)	54 (3.4%)	9 (1.3%)	2 (5.4%)	465 (2.9%)
Nausea and vomit- ing (occasional) (37.6%)	1,465	223 (32%)	4 (14.8%)	1,692 (36.8%)	350 (22.7%)	145 (21%)	2 (5.4%)	497 (21.9%)
Persistent nausea and vomiting (3.1%)	122	22 (3.1%)	0	144 (3.1%)	111 (7.2%)	28 (4%)	1 (2.7%)	140 (6.2%)
Nausea and vomit- ing after treatment. (17.5%)	682	131 (19%)	2 (7.4%)	815 (17.7%)	353 (22.9%)	152 (22%)	6 (16.2%)	511 (22.5%)
Nausea and vomit- ing for more than 24 hrs. after treat- ment (1.6%)	60	4 (0.6%)	1 (3.7%)	65 (1.4%)	2 (0.13%)	0	0	2 (0.09%)

This table shows the marked decrease in cardiovascular complications, persistent restlessness and delirium in group 2 as compared with group 1. The increase of persistent nausea and vomiting was due largely to the fact that a larger number of the ten hour sessions were given in this group, and these complications usually developed during the last few hours of the session. The de-

crease of cardiovascular complications lessens the possibility of death during treatment, since such complications can reasonably be one of the most likely causes of death during or after a treatment, owing to the great increase of work for the heart and the reflection of this increased work on the remainder of the cardiovascular system. Restlessness and delirium during a fever session were important because of the greater difficulty in managing the patient when they persisted. Nausea and vomiting, although frequent complications, rarely were the cause of termination of treatment. In cases in which they were persistent, the fluid and chloride balance was maintained by intravenous injections of physiologic solution of sodium chloride.

Numerous other complications presented themselves during and after treatment, some being troublesome and others of a relatively minor nature. In group 1 herpes labialis developed after treatment in 34.6 per cent of the patients, and in group 2 it was present in 44.8 per cent. In most instances it developed after the first fever treatment, and it rarely recurred after subsequent treatments. However, it has developed in several patients after the second treatment and has occurred as late as the sixth treatment. In 1 case it occurred after the first treatment and again after the ninth session in the same course of treatment. All the patients who had herpes had healing without scar formation despite the fact that several had extensive involvement of the lips and face. Corneal herpes has rarely been observed and has caused no disabling defect.

Moderate to severe headaches during treatment were complained of by 162 of the 4,609 patients of group 1 and by 109 of the 2,272 patients of group 2. This distressing complication was noted in 137 patients of group 1 and in 207 patients of group 2 after treatment.

Extreme weakness from one to several days after treatment was present in 74 patients of group 1 and in 102 patients of group 2. The incidence was greatest in those subjected to ten hour sessions of fever at bodily temperatures of 106 to 107 F.

Distressing abdominal pain and distention were noted in 8 to 10 per cent of the patients at one time or another and were probably due in part at least to the ingestion of iced salt water.

Dyspnea, cyanosis, numbness of extremities, severe pains in the back and chest, epistaxis and hiccups have been observed rarely. Paralytic ileus followed by recovery occurred in 1 patient after 1 treatment in 1934. Acute nephritis developed in 3 patients treated in 1934 and 1935. Transient aphasia developed in 1 patient.

Treatment was terminated in 1 case because of a large number of blisters, and in another case, because the patient had an unusually sensitive skin, treatment was stopped early to prevent the possible development of burns. In 9 cases no further treatment was given because of burns which were present at the completion of a fever session. In a number of cases small blisters developed which did not interfere with further treatments. The most severe burns occurred in group 1 and were due to the fact that the patient was exposed to temperatures in the cabinet of 140 to 155 F. However, with temperatures in the cabinet at 108 to 118 F., as used at present, the possibility of severe burns is remote.

During a course of fever therapy there was either a gain or a loss of weight, but most patients lost weight. The gain in weight was due to the ingestion of an excess of fluid. In a group of 962 patients who received courses of 1 to 20 fever treatments the average loss of weight was 2.1 pounds. The normal weight was usually regained in two to seven days after the last fever session.

Summary

1. A brief outline of the basic requirements for artificial fever therapy is presented.

2. Of 6,881 fever sessions given to 1,200 patients, 5,428 were given at levels of 105 to 107 F.

3. The complications of fever therapy are presented, there having been a significant decrease in the serious complications during the last two and three-quarters years as compared with the previous four and one-quarter years.

4. One death occurred in the group of 1,200 patients receiving 6,881 fever treatments. No death has resulted from treatment during the past five years and two months.

Conclusions

Artificial fever therapy can be given at present with relative safety and ease, providing the fever therapy department is properly equipped, located in a recognized hospital and operated by properly trained physicians and nurse-technicians.

References

1. Johansen, F. A., and Trautman, J. A.: Fever Therapy in Leprosy, *Internat. J. Leprosy* 7:365 (July-Sept.) 1935.
2. Slaughter, W. H., and Trautman, J. A.: Present Status of Fever Therapy, *New Orleans M. & S. J.* 89:6 (July) 1936.
3. Trautman, J. A.; Stroupe, H. V., and Deylin, D. J.: Fever Therapy in Gonococcal Infections, *Am. J. Syph., Gonor. & Ven. Dis.* 22:48 (Jan.) 1938.
4. Trautman, J. A.: Summary of Results Obtained in Fever Therapy at U. S. Marine Hospital, New Orleans, Louisiana, from June 1, 1934 to September 10, 1938, *Hosp. News, U. S. P. H. S.* 6:1 (Feb. 1) 1939.
5. _____: Complications of Fever Therapy—Report of 4,609 Treatments in the Kettering Hypertherm, *Hosp. News, U. S. P. H. S.* 6:26 (Feb. 1) 1939.
6. _____: Hyperpyrexia, The Indications and Complications with an Evaluation of the Results Based on 5,500 Fever Sessions, *New Orleans M. & S. J.* 92:630 (May) 1940.
7. _____: Fever Therapy in Gonococcal Arthritis and Epididymitis, *Arch. Phys. Therapy X-Ray Rad.* 17:277 (May) 1936.
8. Trautman, J. A., and Stroupe, H. V.: Artificial Fever in the Treatment of Asymptomatic Neurosyphilis, *Hosp. News, U. S. P. H. S.* 5:10 (May 1) 1938.



THRESHOLD OF STIMULATION OF ALTERNATING CURRENTS *

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D'Arsonval¹ first studied the influence of frequency of an alternating electric current on sensation. He stated: "I began, in 1881, the study of the physiologic properties of alternating currents of all frequencies. I went up to only 10,000 frequencies and I was able to demonstrate their complete innocuousness at a sufficient frequency." Bourguignon,² in writing of d'Arsonval, added "In December, 1890, by substituting for his (d'Arsonval's) apparatus which could produce no more than 10,000 excitations per second, Hertz's apparatus, which gave several billions of excitations per second, d'Arsonval saw the disappearance of every muscular or nervous excitation, motor or sensory." D'Arsonval apparently studied alternating currents up to a frequency of 10,000 and then jumped to frequencies of millions per second. If he measured the exact frequencies, this is not recorded in the articles mentioned. It is likely that no precise determination of frequency was made, since the measuring instruments were not developed to the degree of accuracy attained at the present time. The high frequency electrical currents used by d'Arsonval were generated by the spark gap and not by the thermionic tube, which had not been invented at that time.

It seems conclusive, therefore, that d'Arsonval first established the fact that if the frequency of an alternating current is increased sufficiently the current will not bring about electrolytic changes in the tissue fluids, as do the galvanic currents, and that neither will high frequency currents stimulate nerve and muscle tissue, as do low frequency alternating currents.

The minimum frequency of the alternating current required to permit its passage without neuromuscular response depends on the strength of the current. The stronger the current the greater must be the frequency of its oscillation. Cumberbatch³ stated that this frequency need not be greater than 10,000 cycles per second if the strength of current is no more intense than the maximum employed in treatment by the sinusoidal current. According to this investigator the intensity is measured in milliamperes and would be insufficient to heat the tissues: To heat tissues the current must have a strength of 1 or more amperes and the frequency must be at least 300,000 cycles per second. Cumberbatch³ stated that in actual practice a frequency of 500,000 cycles per second is the minimum necessary to eliminate completely neuromuscular response.

Asher,⁴ working on frog muscles, found that there seemed to be a relation between frequency and the threshold value of stimulating current within frequency ranges from 10,000 to 300,000 cycles per second.

Cluzet and Ponthus⁵ found that as the frequency of alternating current increased the threshold of stimulation decreased, but as the frequency of rectified high frequency currents increased the threshold of stimulation increased.

Cumberbatch⁶ declared that the body offers less opposition to the passage of oscillatory currents than to the passage of the galvanic current. If

* Read at the Twentieth Annual Session of the American Congress of Physical Therapy, Washington, D. C., September 2, 1941.

the frequency of the current is high, the opposition (impedance) is less. Rosendal⁷ observed by means of a separate determination of impedance and phase angle* of the skin at 30 to 20,000 cycles that the impedance is inversely proportional to the electrode area, while the phase angle is independent of the area of the electrode. He stated that the impedance and the phase angle of the skin can only be located in the stratum corneum, in contradistinction to most of the earlier views on this problem. At frequencies between 500 and 20,000 cycles, the impedance Z of the stratum corneum (of an area of 5.35 sq. cm. of the forearm) can be expressed as

$$Z = k.w.^*, \quad a = 0.80,$$

Z , the impedance, determined on 76 test persons, lies between 172 and 219 ohms at 10,000 cycles per second. The phase angle, ϕ , determined on 76 test persons in the same frequency range, amounted to 81 ± 0.36 degree. At frequencies below 500 the frequency dependence is not valid and ϕ decreases with decreasing frequency.

It is usually believed⁸ that when the horny layer of the epidermis is dry it prevents the passage of the galvanic current but does not prevent the passage of a diathermy current. It is interesting to note that Rosendal's experiments⁷ show that after the skin is moistened with 1 per cent sodium chloride solution the impedance Z in ohms falls 10 to 20 per cent, the fall being most marked at low frequencies. He stated that as a cause of this decrease it can be assumed—in accordance with the opinion of Einthoven and Bijtel—that repeated moistening of the stratum corneum results in a penetration of the cell channels with 1 per cent sodium chloride solution and gives rise to a better conduction, since the decreased resistance in these channels acts like a shunt. Rosendal's experiments seem to substantiate this conclusion, since there is found a decrease in the phase angle in addition to the decrease of the total impedance at low frequencies (below 500 cycles), which can be explained by a difference in the effect on the resistance and reactance component which determines the magnitude of the phase angle.

Another experiment conducted by Rosendal⁷ was to determine the influence of sweat exudation on impedance and the phase angle of the stratum corneum. Impedance Z and phase angle ϕ of the stratum corneum were measured at 2,000 and 10,000 cycles before a short wave diathermy treatment. After a twenty minute treatment a violent universal sweat secretion was found without hyperemia of the part measured. There was a marked decrease of impedance of the stratum corneum but no such decrease of the phase angle. This decrease of the impedance Z is greater than that obtained by repeated moistening of the skin. Therefore, apparently the sweat secretion acts to moisten the stratum corneum with a well conducting electrolytic solution.

Recently the threshold of perception was determined for direct current and commercial 60 cycle alternating current by Dalziel and Lagen.⁸ Each subject sat in a relaxed position in a chair with the hands resting on two No. 7 copper wire electrodes. The hands were moistened with sodium chloride solution in order to reduce contact resistance and permit the use of low voltages for safety. The current was gradually increased so that the subjects might become acquainted with the faint sensations of warmth and tingling. Repeated tests were then made to determine the smallest current that could be felt. The average 60 cycle threshold current for 115 men was 1.1 milliamperes. The average threshold of perception for direct current for these 115 men was 5.2 milliamperes.

* Rosendal gave a definition for phase angle which corresponds to definition of power factor.

According to Best and Taylor⁹ the application of electrical as well as of mechanical or heat stimulation will react on the end organs of Ruffini, giving rise to a sensation of warmth. The variability in sensation may possibly be related to a corresponding fluctuation in the capillary circulation. The observations of Bazett and associates indicate that the diffuse nature of the temperature sensations in hyperemic skin can best be explained on the basis of a more ready conduction of the heat through the blood stream to neighboring end organs; thus when the cutaneous blood flow is profuse, heat applied to a nonsensitive point in the skin is conducted rapidly to adjacent warm spots. These observations support the conception of heat and cold spots and the existence of discrete receptor organs for these sensations.

That more alternating current will pass through the tissues of the living body without sensation as the frequency increases has been known for many years, but there does not appear to be any record of more recent experiments with more modern equipment.

First Experiment

Apparatus.—The apparatus used in this survey consisted of a beat frequency oscillator, manufactured by the Radio Corporation of America, having an unlimited frequency range (sweep) between 40 and 15,000 cycles per second, a special oscillator to cover the ranges from 15,000 to 48,000 cycles per second (the top frequency investigated), a Thordarson 50 watt amplifier, a Weston output meter recalibrated to read in milliamperes and two brass electrodes each 1 cm. in area.

To determine the resistance of the skin, a source of 220 to 110 volt direct current and a potentiometer, a suitable double-throw switch and a resistance box were added. The brass electrodes were 1 sq. cm. in area.

Procedure.—Some of the data recorded herein were gathered in the Department of Physical Therapy of the Out-Patient Department at Northwestern University School of Medicine and some in an exhibit given by one of us at the American Congress of Physical Therapy in Cleveland. Since the subjects were volunteers and convention visitors, it was advisable to select a part of the body for observation at which the risk of electric shock would be at a minimum. Hence the fleshy parts of the thumb and index finger of 107 subjects (60 men and 47 women) were used, because the current passing through these digits is far removed from the heart. The subject was asked to hold the thumb and index finger firmly on the brass contacts but not too tightly. The frequency was selected and the current increased by the control of the amplifier until the subject said he felt a pulsating sensation. The alternating current passing through the ammeter was then recorded. The fleshy parts in contact with the electrodes were examined for callouses, cuts and scars, and the hand was examined for moisture. When the results were tabulated the observations on sweaty and moist skin surfaces were included. Readings taken on calloused or scarred fingers were excluded.

Figure 1 and table 1 are self explanatory. It would appear from the curves, representing ages roughly from 17 to 75, that in general the current density per square centimeter of the finger and thumb, the threshold of feeling being used as the index, is directly proportional to the frequency.

To determine the average resistance of the skin of the thumb and forefinger, 59 subjects were used. The direct current threshold was first observed, which was described by the subject as a stinging sensation. The potentiometer was adjusted to a point of minimum sensation in the thumb or index finger. The resistance of skin was obtained by the method of com-

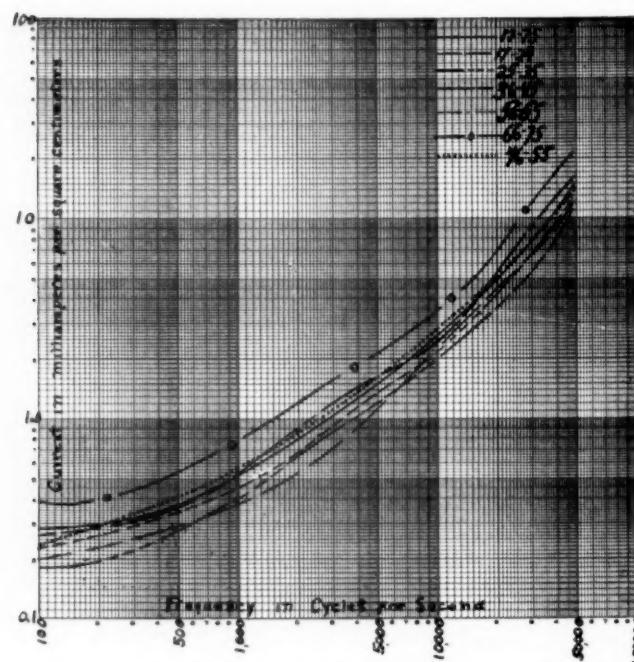


Fig. 1. — Curves showing the relation between frequency and intensity of alternating current, the threshold of electrical stimulation being used as an index. The electrodes were dry, but sweating occurred in some instances. The average for 107 subjects, 60 men and 47 women, is shown.

parison. The current required to obtain a threshold stimulation was observed, and by means of a switching arrangement a resistance box of some 1,000 to 100,000 ohms was substituted in the circuit for the electrodes to the thumb and index finger. With the resistance box in the circuit, the current was brought to the same strength as that flowing through the digits

TABLE 1. — Average, Minimum and Maximum Determinations of 107 Observations in Five Age Groups (Averages Plotted in Figure 1).

Frequency in Cycles Per Second.

Age Groups	100	500	1,000	2,000	6,000	15,000	35,000	48,000
17-24	Min. .... .10	.15	.2	.35	.8	1.5	5.0	8.0
	Aver. .... .204	.290	.373	.542	1.380	3.300	7.80	12.00
	Max. .... .325	.375	.50	.7	1.75	3.75	11.0	17.0
25-35	Min. .... .1	.15	.2	.350	.800	1.75	3.	5.
	Aver. .... .184	.284	.401	.658	1.388	2.907	6.63	11.35
	Max. .... .375	.425	.825	1.17	2.50	4.50	14.0	17.0
36-45	Min. .... .02	.2	.25	.375	1.0	2.4	3.	4.
	Aver. .... .226	.338	.469	.679	1.539	3.205	8.33	12.43
	Max. .... .4	.60	.80	1.3	2.5	4.0	13.	16.
46-55	Min. .... .05	.2	.35	.5	.6	1.0	1.5	6.
	Aver. .... .237	.404	.563	.828	1.934	3.800	9.01	13.89
	Max. .... .40	.60	.90	1.5	3.5	7.0	20.0	25.0
56-65	Min. .... .1	.2	.425	.65	1.5	2.50	5.00	9.0
	Aver. .... .260	.375	.550	.884	1.800	3.590	11.0	15.90
	Max. .... .375	.60	.90	1.30	2.75	5.0	15.0	27.5
66-75	Min. .... .375	.50	.70	1.2	2.25	5.0	15.0	20.0
	Aver. .... .387	.550	.750	1.2	2.37	5.0	15.0	21.25
	Max. .... .400	.60	.80	1.2	2.5	5.0	15.0	22.5

TABLE 2.—*Threshold of Electrical Skin Sensation on Thumb and Forefinger for Direct Current and Average Resistance of the Skin at Sensation Threshold Current (Direct Current)**

Direct Current—Thumb and Forefinger.

Age Groups	Number of Subjects	Current in Milliamperes/Sq. Cm. for Threshold (Average)	Resistance in Ohms/Sq. Cm. (Average)
17-24	13	.252	72,720
25-35	21	.304	116,660
36-45	11	.36	111,360
46-55	8	.346	105,710
56-65	4	.331	92,500
66-15	2	.157	110,000
17-75	59	.291	101,000

* Two brass electrodes 1 sq. cm. in area were used. Observations were included whether or not the subjects' hands were dry or moist.

for which readings had been made previously. The conditions of the circuit remained the same except for the substitution of the resistance box for the thumb and index finger. Thus the reading on the resistance box corresponded to the resistance of the skin and tissues. Table 2 gives a summary of the results.

The data collected by the Underwriters' Laboratories in connection with its survey¹¹ on electrified fences coincides closely with the information contained in this survey.

Figure 2 is a schematic diagram of the complete apparatus.

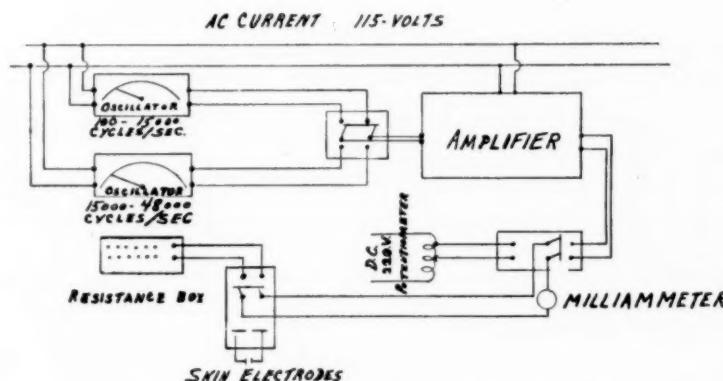


Fig. 2.—Schematic wiring diagram of apparatus used.

Second Experiment

Apparatus.—The apparatus employed in the first experiments, namely the two oscillators, amplifier and meter, were used. In this experiment three sizes of brass electrodes were part of the equipment. There were two of each, $\frac{5}{8}$ inch, 1 inch and $2\frac{1}{4}$ inches in diameter. A source of direct current and a resistance box were also used in this investigation.

Procedure.—The medial and lateral aspects of the distal part of the upper arm were selected. These areas of the body were chosen because they are likely to be free from hair and yet at a point where currents will not come dangerously near the heart. The skin under the electrodes was moistened with physiologic solution of sodium chloride. Fifteen subjects of ages roughly from 20 to 30 were tested in this investigation.

Figure 3 and table 3 show the results.

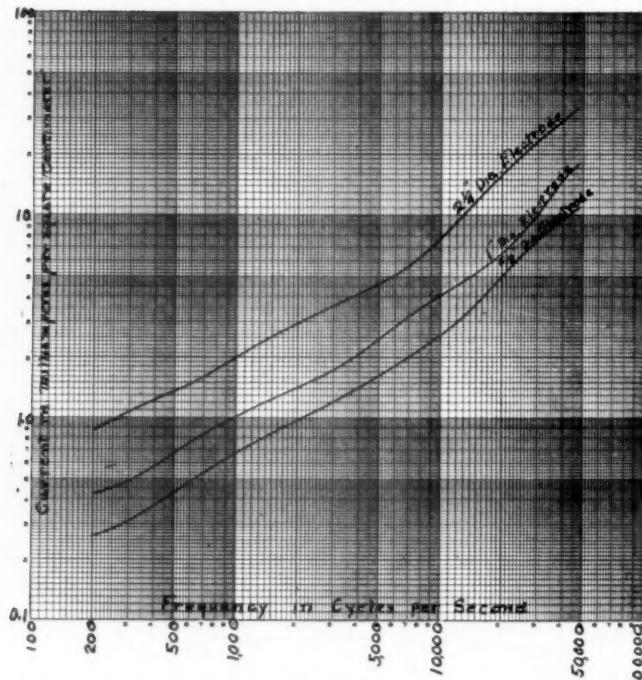


Fig. 3. — Curves, showing the alternating current required for the threshold of stimulation as the frequency varies. Three sizes of electrodes, e. g. $\frac{5}{8}$ inch, 1 inch and $2\frac{1}{4}$ inch in diameter, were used. Physiologic solution of sodium chloride was applied between the electrode and the skin. The average for 15 subjects, 5 men and 10 women, aged 20 to 30 years, are shown.

TABLE 3. — Average, Minimum and Maximum Determination on 15 Subjects Aged 20 to 30 Years (Averages Plotted in Figure 2).

Frequency in Cycles/Second.

Size of Electrode $\frac{5}{8}$ in.	200	500	1,000	2,000	6,000	10,000	15,000	35,000	48,000
Min. ....	.100	.25	.300	.40	.80	1.3	1.5	3.0	4.0
Aver. ....	.26	.43	.67	.98	1.81	2.58	3.65	8.50	11.05
Max. ....	.55	.70	1.000	2.00	3.50	3.75	5.7	15.0	17.0
1 in.									
Min. ....	.15	.275	.40	.50	1.1	2.10	3.5	6.1	10.0
Aver. ....	.435	.69	1.08	1.42	2.82	1.1	5.27	13.2	17.8
Max. ....	.6	1.0	1.4	1.75	4.0	7.00	11.0	22.5	35.0
$2\frac{1}{4}$ in.									
Min. ....	.4	.6	1.0	1.5	3.0	4.2	6.0	13.0	23.0
Aver. ....	.87	1.39	2.04	2.92	5.01	7.98	11.65	26.30	34.30
Max.	1.75	2.25	3.25	5.0	9.0	15.0	20.0	41.0	51.0

Determinations were made of the resistance of the skin on the distal portion of the arm by the method described in experiment 1 for obtaining skin resistance, namely substitution of the resistance box for the skin electrodes. The results are shown in table 4.

Comment

Those persons who were tested in experiment 1 (thumb and forefinger) reported on the sensation at a frequency of 48,000 cycles per second. Some reported a definite sensation of heat, whereas others observed a tingling sensation. In experiment 2, in which the electrodes were larger, the subjects

TABLE 4. — *Average Direct Current and Average Resistance for Threshold of Sensation as Observed on 15 Subjects.**

Electrode Diameter in Inches	Area in Sq. Inches	Area in Sq. Centimeters	Current in Milliamperes Av. of 15	Current Per Sq. Cm. M.A.	Resistance in Ohms Ave. of 15
5/8 in.	0.31	2.0	0.261	1.30	47,500
1 in.	0.79	5.1	0.475	0.94	28,200
2 1/4 in.	3.9	25.2	0.801	0.032	14,000

* The medial and lateral surfaces of the distal portion of the upper arm were the sites of application. The cutaneous surfaces were moistened with physiologic solution of sodium chloride.

did not mention a sensation of heat but reported a tingling sensation at 48,000 cycles per second.

A rough determination was made (not recorded here) to determine whether there was a difference in the average strength of the alternating current at the threshold of sensation among the persons having dry skin and those having damp skin. Within the error of observation no definite trends were observed. However, the resistance of the skin to direct current was lowered if the skin was moist either naturally or artificially.**

Summary and Conclusions

Alternating Current. — 1. In general, with the area of the electrode, the place of contact on the skin surface and the pressure remaining the same (while the threshold of electrical stimulation is used as the index) more alternating current may be passed through the body tissues without feeling as the frequency is increased. That is to say, the current under these conditions is directly proportional to the frequency.

2. This study shows that a categorical rule to the effect that electrical stimulation is not felt at certain frequencies of alternating current means little unless the size of the electrode, its composition, pressure and place of application on the skin surface are given.

Direct Current. — 1. No definite rule should be made stipulating the intensity per square centimeter of direct current that may be passed through the skin without feeling, as this depends on: (a) what the size and the composition of the electrode are, (b) whether the area of the skin is moistened with a salt solution, (c) whether the skin is dry or is moist with sweat secretion and (d) to what particular part of surface the electrodes are applied.

2. Each application for ion transfer should be tested for sensation before the current is turned on for the duration of the treatment. Furthermore, a safe current intensity—less than the threshold value—should be chosen, since there is a tendency for the secretions in the skin during treatment to reduce the resistance and thus increase the current density.

** The authors are indebted to Miss Gertrude Yoder for recording a number of the observations and to Mr. Sidney Thompson for adjusting and connecting the equipment.



TREATMENT OF DERMATOPHYTOSIS BY ION TRANSFER *

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The various fungous infections of the hands and feet comprise a prevalent cutaneous disorder. They are considered by several of the leading dermatologists of this country as the most common dermatosis occurring in the summer months, and during the other months of the year they rank as the third most frequent cutaneous infection. Although their incidence is extremely high, they are usually not the most troublesome or disabling of the cutaneous diseases. Fortunately in the majority of cases they are relieved by relatively simple remedies; however, the chronic and more serious forms have been treated with a large variety of therapy without notable results.

In 1936 two French investigators¹ reported the successful treatment of epidermophytosis by the ion transfer of copper sulfate. They were perhaps the first to employ this method. In *The Journal of the American Medical Association* for April 1, 1939² another article appeared which described this method of ion transfer. The results showed that 70 per cent of the patients were cured clinically by an average of slightly more than six treatments. Although the American investigators were not the first to use this method, their report perhaps had the widest publicity. It would seem that the publication of the success of this procedure would have stimulated further interest and that other reports would have appeared in the literature. However, during the past five years only five papers have been listed in the *Quarterly Cumulative Index Medicus* in which this method of ion transfer for tinea infections has been discussed. The outstanding authority on medical mycology in this country, Dr. George Lewis, did not include this physical measure in his consideration of treatment in his book which was published in 1939.³ The apparent lack of interest in the method prompts this preliminary report of the results in 40 patients treated at Cleveland City Hospital during the past six months.

Fungous diseases are usually considered a most difficult and confusing subject, and not the least of the difficulties is the diagnosis. The diagnosis of fungous infections of the skin is similar to that of any form of dermatitis in that an attempt is made to identify the specific etiologic agent if possible. Dr. Lewis in his excellent monograph³ listed fifteen procedures by which it is possible to determine whether fungi are present and to differentiate them into species. Perhaps the simplest criterion is the demonstration of fungi from scrapings or suitable material from the lesions. The typical mycelial threads and spores may be seen by dissolving the material in a 20 per cent solution of potassium hydroxide or sodium hydroxide and examining them under the microscope. Often the demonstration of the fungi by this method is sufficient to establish the diagnosis. Cultural methods are available and have distinct advantages but are much more elaborate, and require considerable time, material and experience. The culturing of the material produces characteristic colony growths, which by further study aid in the identification of the species. In many instances the specific fungi cannot be grown from the scales in which the mycelial threads are seen, but repeated attempts may eventually produce the growth. The cultural method is highly desirable from a scientific aspect, but the procedure is not always possible. An-

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other procedure used in diagnosis is the cutaneous test, which has been tried but is not recognized by all dermatologists. Lewis maintained that:

A most welcome method for diagnosis of a fungous infection would be a test based on specific acquired cutaneous sensitization to a fungus after infection. While sensitization often occurs shortly after infection, it does not do so invariably, and cutaneous tests based on the assumption that the phenomenon is constant often cause confusion. Since sensitization may have been produced by a previous infection, a test based on its demonstration cannot be regarded as unqualifiedly diagnostic.

Furthermore, not all fungi have the power to sensitize the skin. Lewis³ attached more importance to a negative test than to a positive one. He stated that the tests are repeatedly negative he usually considers the condition nonmycotic. An additional method of interest to physical therapeutists is the use of filtered ultraviolet light, or Wood's light, as the radiation is frequently called. The fluorescence of the fungi is a means of identification. This procedure is used primarily in determining the presence of fungous infection in the hair of the head or in studying fungous colonies. Perhaps the most important means of making the diagnosis is the clinical appearance and history, which to certain dermatologists may be sufficient.

The common manifestation of the disease on the feet is the appearance in the interdigital spaces of a heavy white sodden material with scaling extending over the toes and soles. On the hands the lesions are likely to have sharper, slightly raised margins, a pinkish or reddish central area and a scaly or smooth surface. There may be vesicle or papule formation with areas of erythema and edema. Lesions may present an eczematous-like reaction. As a rule they vary in number from a few to a dozen or more. There is a wide variation in the clinical appearance, and these descriptions are by no means complete. Itching and burning may be present and are often a severe feature of the disease.

The fungi are found in the deep layers of the epidermis; so, in order to eradicate the infection, either the skin must be desquamated, as with a keratolytic, to expose the organism, or an agent must be deposited into the skin which will serve as a fungicide. It has long been recognized that copper is one of the best fungicides. This metal has the added advantage of a low toxicity for the tissues of the body. By the action of the galvanic current the copper ions are deposited locally in the skin. Although the depth of penetration of this metal has not been determined, it has been found that methylene blue by ion transfer extended in rabbits to the intramuscular connective tissue and in the human skin to the epithelial layer, with more extensive penetration of the hair follicles.⁴ It has also been shown that in rats² in which the legs were submerged in a copper sulfate solution and 6 milliamperes of current allowed to flow for twenty minutes 0.5 mg. of copper was deposited. Since the pathogenic fungi are to be found chiefly in the dead portion of the skin, including the horny layer of the epidermis and the hair follicles, the penetration of the copper ions is sufficient to reach them. The action of the current deposits the free copper ions in the skin, which in turn produces a protein precipitate. It is the presence of these free ions which secures the definite germicidal effect in the part treated. The result of the combined action of the electrical current and the fungicidal power of the copper is the formation of a slough over the denuded area and the stimulation of a new healthy granulation tissue.

The apparatus and material required for this procedure are available in all physical therapy departments. Any source of controlled galvanic current is satisfactory. When the feet are being treated, large, deep rectangular pans are most convenient, and for the hands, bains-marie are suitable. The positive pole is connected to the copper electrode, and the negative pole is attached to the dispersive pad, which may be placed at any convenient part of the body. One may use bains-marie as the dispersive electrode when treating the feet by placing

saline solution in them and immersing the hands in them; when the hands are being treated one may put the saline solution in the rectangular pans. One per cent copper sulfate solution is used; this strength permits sufficient dissociation.

The only preliminary preparation of the part to be treated consists in its proper cleansing. The feet or the hands are thoroughly washed with soap and water before the first ion transfer treatment is given. This tends to remove the greasy exudate, the crusts and the scales. The usual precautions are taken as to the danger of the electrodes touching the skin. If both hands or both feet are involved, they may be treated simultaneously. To enable the solution to enter the interdigital spaces, a small amount of cotton is placed between the toes, which spreads them apart. The amount of current employed is usually 4 to 6 milliamperes if one foot or one hand is treated and double this amount if two feet or two hands are treated at the same time. Stronger currents are apparently not necessary. The length of the treatment is thirty minutes. The procedure is well tolerated by the majority of the patients; occasionally a sensitive person will complain of a sensation of stinging or burning, in which case the milliamperage may be decreased or the time shortened. If possible the treatments are given every day or three times a week.

The series under discussion consists of 40 patients treated in the Physical Therapy Department at Cleveland City Hospital. A simple microscopic examination was made in the majority of the cases, and cultural studies were employed in a few. Cutaneous tests were not used. There were 28 female and 12 male patients. All but 2 were white. The age varied from 14 to 71, with an average of 36. The duration of the symptoms and signs varied from two to nineteen years, with an average of two and a half years. The infection was confined to the feet in 15 patients and to the hands in 25; in 4 both the feet and the hands were involved. In all but 2 patients the involvement was either moderate or severe. This classification is based on the size of the area involved and the condition of the lesions. This arbitrary distinction in the clinical picture is included to show that practically all the patients had more than the simple, mild involvement which is so frequently seen. Only 4 patients in the series had had no other type of therapy before the ion transfer of copper sulfate was given. The others had been treated with the various ointments, powders and soaks which are frequently prescribed, and 5 had been given at least one series of treatments with roentgen rays without showing improvement. The average number of treatments given was thirteen. The least number necessary to heal the skin completely was six, and the largest number given was thirty-four. Symptomatically the majority of the patients were helped after the second or third treatment.

The results objectively were as follows: healed, 9 patients; markedly improved, 17; improved, 11, and unimproved, 3.

In analyzing the results it was found that the duration of the disease in those patients in whom the lesions were considered healed or cured averaged less than one year. The number of treatments required to secure the result was fourteen. In the group considered markedly improved the lesions had existed for approximately two and one-half years and the average number of treatments necessary to secure the result was thirteen. In the patients included in the improved group, the disease had been present for approximately four years. The number of treatments for this group also averaged thirteen. In the 3 patients in whom no improvement occurred, neither the degree of involvement nor the duration of the infection appeared to be the cause of the failure. One patient had had the fungous infection on her feet for only one month, but the cooperation was not satisfactory and after sixteen treatments other measures were tried. Another patient had had a moderate involvement of her hands for one year. After nine treatments she became discouraged, and roentgen ray therapy was given, with no better results. The other patient was a young man whose hands

had been affected for two years. After twenty treatments the lesions had extended and more vesicles had appeared; so the ion transfer of copper sulfate was discontinued and a series of roentgen ray treatments given. This secured improvement. From these figures it would seem that the shorter the duration of the disease, the better the results. The number of treatments given was approximately the same for the various groups.

The final results of this therapy have not been determined. No attempt as yet has been undertaken to follow up these cases. Relapses have occurred. This is not surprising, since all the patients were from the dispensary of the city hospital. These persons if not on relief have a meager income, so that precautions or prophylactic measures to prevent reinfection are often impossible. However, to date, 9 patients have reported back with a return of their symptoms and signs. One author⁴ suggested that a monthly treatment might be given as a prophylaxis in an effort to prevent recurrences, and this procedure would be definitely beneficial for this class of patients if their cooperation could be secured. It would appear that the reinfections with this method of therapy are no more frequent than they are with other types of treatment.

Summary

Forty patients with fungous infection of the hands and feet were treated with the ion transfer of copper sulfate.

The lesions were healed completely in approximately 22 per cent of the patients, markedly improved in 43 per cent, improved in 28 per cent and not benefited in 7 per cent.

The results thus far observed would tend to prove that the ion transfer of copper sulfate is a satisfactory method of treating and relieving the symptoms of this troublesome cutaneous disease. This physical therapeutic method is certainly not the only measure which can be employed; furthermore it is not the simplest, the most convenient or even the least expensive. However, the results in the series presented show that it is possible by this method to bring about a rather prompt improvement when more conservative or routine types of therapy have failed.

References

1. Jersild, O., and Plesner, M.: Traitement de l'épidermophytie des extrémités par iontophorèse de cuivre, *Bull. Soc. franç. de dermat. et syph.* **43**:450 (Feb.) 1936.
2. Haggard, H. W.; Strauss, M. J., and Greenberg, L. A.: Fungous Infections of the Hands and Feet Treated by Iontophoresis of Copper, *J. A. M. A.* **112**:1229 (April 1) 1939.
3. Lewis, George M., and Hopper, Mary E.: *An Introduction to Medical Mycology*, Chicago, The Year Book Publishers, 1939.
4. Loveman, Adolph B. (and other authors): Symposium on Practical Management of Eczematous Ringworm of Hands and Feet ("Athletes' Foot"—Dermatophytosis and Dermatophytids), *J. Invest. Dermat.* **3**:523 (Dec.) 1940.
5. Harpuder, Karl: Electrophoresis in Physical Therapy, *Arch. Phys. Therapy* **20**:221 (April) 1937.



STUDIES ON THE CAUSE OF PAIN IN ISCHEMIA *

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Pain is one of the main symptoms of peripheral vascular disease and its treatment one of the most important therapeutic problems. It may be caused by inflammation, it may be neuritic or it may be the result of an insufficient supply of blood to the tissues. Ischemic pain occurs suddenly in arterial embolization or in arterial thrombosis prior to and during the early stages of dry gangrene. It appears as a chronic or intermittent manifestation when the flow of blood through diseased and narrowed blood vessels does not correspond with the requirements of active tissues, for example, in intermittent claudication during muscular exercise.

Although ischemic pain has held the interest of physicians for many decades, it was Sir Thomas Lewis¹ and his co-workers who first investigated the problem thoroughly and successfully. They showed that ischemic pain may be produced experimentally in a healthy extremity by arrest of its circulation and the performance of muscular work. They came to the following conclusions: 1. Ischemic pain occurs only in a contracting muscle. 2. It is not relieved by rest but is relieved within a few seconds by the release of the circulation. 3. It does not depend directly on the lack of oxygen during ischemia. 4. It is probably caused by a chemical substance, a normal metabolite of muscular contraction, designated by Lewis as P substance. Time does not permit me to go into any details of Lewis' masterful observations.

A number of attempts have been made since then to identify the P substance.² Organic and inorganic substances connected with the metabolism of the muscle have been injected subcutaneously, intramuscularly and even intravenously, with the purpose of testing their ability to produce, facilitate or counteract ischemic pain. Among such substances investigated have been lactic acid, ammonia, potassium, histamine and sodium bicarbonate. The results in each instance have been either inconclusive or negative. Moreover, the injection method is too coarse and too unphysiologic to allow reliable conclusions.

Dr. I. D. Stein and I have for the past one and a half years attempted to repeat and amplify Thomas Lewis' clinical studies and to correlate our observations with chemical investigations of the P substance. Our work can be divided into three parts: (1) studies to decide whether ischemic pain occurs only in an exercising muscle or is a more general tissue response, (2) clinico-experimental studies to clarify further the mechanism of ischemic pain and (3) identification of the cause of ischemic pain.

Clinical experience certainly favors the assumption of ischemic pain in tissues other than working muscle. Superficial gangrene of the tip of the toe announces itself by severe pain. If the circulation of an arm is arrested by a pressure of 200 mm. of mercury and a finger of the corresponding hand is immersed in water of 115 F., stabbing pain appears in the finger after

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sixty to ninety seconds and is severe at one hundred and twenty seconds. There are no simultaneous changes in the threshold to other painful stimuli and no obvious sensory changes. The pain is slowly and incompletely relieved when the finger is removed from the hot water. If, on the other hand, the occlusion is released, the pain is almost immediately relieved. When the same experiment is carried out with ice water, there is a feeling of intense cold but no pain during the observation period of four minutes. When a finger is first treated by ion transfer (1:10,000 epinephrine, 3 to 4 milliamperes, ten minutes) and then, after the arrest of circulation, is immersed in water of 115 F., stabbing pain appears in three or four seconds and is almost unbearable in fifteen to twenty seconds. The finger remains blanched after release of circulation although the rest of the extremity shows a reactive hyperemia. Substitution of histamine or mecholyl for the epinephrine, however, does not alter the reaction of a finger to an arrest of its circulation and immersion into water of 115 F. The simplest explanation for the production of pain would be the accumulation of heat in the occluded finger which must actually increase its cutaneous and deeper temperatures considerably more than when its circulation is intact. Militating against this simple assumption, however, is the lack of a similar painful reaction on exposure to cold and still more the marked effect of a topical application of epinephrine, which cannot essentially alter the thermophysical qualities of the finger. It can only constrict superficial cutaneous vessels. One might, therefore, assume that the pain under our experimental conditions is true ischemic pain produced under the influence of heat by an increased metabolism in an ischemic skin.

If the circulation to an arm is arrested and forceful contractions of the hand are carried out forty to sixty times in one minute, a dull ache appears in the flexor muscles of the forearm which soon becomes severe. During this ischemic exercise of one forearm and hand the systemic blood pressure measured on the contralateral arm rises from 20 to 60 mm. of mercury systolic and from 20 to 40 mm. diastolic. This is apparently the result of a nervous reflex. When exercise is stopped, the pain and hypertension remain unchanged. Release of circulation causes immediate relief of pain and a drop of the blood pressure to normal. The rise in blood pressure is sometimes but not always accompanied by an increased pulse rate. The pupils remain unchanged. Similar results are obtained by a steadily maintained contraction of the hand or by direct or indirect electrical stimulation of the muscles of the forearm under ischemic conditions for four to six minutes.

On release of the circulation the pain disappears within two to four seconds. If pressure is then thrown on the arm and contractions are commenced, only five to ten contractions can be carried out. With an increase in the duration of the rest period the number of contractions in the second part of the experiment increased proportionately, so that after a recovery period of three minutes or more the original number of ischemic contractions can again be performed. If after ischemic exercise the occluding pressure is partially released, let us say in stages of 20 mm. of mercury, the pain diminishes each time for a little while, only to reappear fully until the pressure falls below 80 mm. of mercury.

These briefly described results of ischemic muscular work are not essentially altered by producing hyperemia in the forearm prior to the arrest of circulation, whether caused by direct heat or reflex heat or as reactive hyperemia. When ischemic exercise is carried out with the forearm immersed in water of 110 F., pain appears somewhat sooner, although not markedly so, and in cool water of 65 F. somewhat later than usual. In

water of 110 F. a forearm with arrested circulation starts to ache moderately and the muscles feel fatigued after eight to ten minutes even without exercise.

If muscular work is performed first with intact circulation and continued after arrest of blood flow, pain appears after a fewer number of contractions than usual, thirty instead of forty. If, however, both legs carry out ischemic work to the limit of endurance and the circulation is released, the number of contractions possible in an upper extremity, the circulation of which was arrested twenty seconds later, is within normal limits. The cause of ischemic pain is therefore produced subliminally during normal muscular exercise with intact circulation and is not measurably transferred from one extremity to another.

For an explanation of the described observations one has to consider several possibilities. Thomas Lewis and more recently Rein and his co-workers³ have shown that in ischemia there is a vasodilatation distal to the site of the vascular obstruction. From Hinsey⁴ it is known that the blood vessels of the striated muscle contain pain receptors. Might ischemic pain be the result of excessive dilatation of empty blood vessels? Our observations on hyperemia and on exercise preceding ischemic contractions are in contradiction to such hypothesis. However, we have injected histamine biphosphate, mecholyl and papavarine hydrochloride in suitable doses into a femoral artery with and without arrest of circulation. Peripheral hyperemia was marked and is—at least for the first two substances—known to involve muscle vessels. No pain was noticed.

If, then, a chemical or physicochemical factor is responsible for ischemic pain, it must be subliminally produced during normal muscular contraction and it must diffuse rapidly into the blood stream or be rapidly destroyed locally after the release of the circulation.

For the latter possibility only an oxidation could be responsible. Thomas Lewis has shown that lack of oxygen is probably not the cause of ischemic pain. We have carried out on ourselves experiments in which we breathed air from a rubber bag of gradually decreasing oxygen content to a minimum of 7 to 8 per cent. When cyanosis and respiratory distress appeared, the circulation of an arm was arrested. The experimentee was able to perform the usual number of ischemic contractions and obtained the usual complete and immediate relief of pain on release of circulation in spite of a calculated oxygen deficit of 40 per cent in the arterial blood. This is in sharp contrast to the work of Kissin.⁵ It appears extremely unlikely that lack of oxygen is the cause of ischemic pain. The pain factor must therefore be carried away by the blood stream. To conform to our observations it must, I repeat, be a normal cell or muscle constituent released during a normal muscular contraction. During ischemic muscular contraction it must be sufficiently accumulated to produce pain and it might even be responsible for the normal hyperemia of exercise and the hypertension during ischemic exercise. It must enter the circulation with such speed as to decrease its tissue concentration to below the pain—and possibly the hypertension—levels within a few seconds and to return to a resting value within three minutes. In entering the circulation it cannot upset its blood equilibrium enough to cause effects on distant muscles. From all this we come to the conclusion that the pain factor must be a normal blood constituent; it must be increased in venous blood immediately after ischemic exercise and should drop down to its normal level again within three minutes of rest. All our chemical investigations were therefore carried out on blood from an antecubital vein, the samples being taken (1) at rest, (2) ten seconds after ischemic exercise

and release of circulation and (3) three minutes later (rest, exercise and recovery samples).

A number of substances investigated in this way did not show the required changes and cannot be made responsible for ischemic pain. The list includes lactic acid, ammonia, histamine, acetylcholine and epinephrine. I cannot go into details of methods or the explanation for taking each of these substances into consideration. Studies of the alkali reserve, of the electric conductivity and of the oxidation potential of the blood serum proved fruitless.

The only blood constituent to conform to our experimental requirements —i. e. to rise from a resting level immediately after ischemic exercise and to return to its previous value after a three-minute recovery period—is serum potassium. The elevation is not very high—20 to 25 per cent. The difficulties of potassium estimations in blood serum are well known. The recent method of Somogyi and his co-workers⁶ has been employed with the greatest care and has given satisfactory results in duplicates and triplicates. Control experiments were carried out with exercise under normal conditions and with arrest of circulation without exercise. They showed no appreciable elevation of serum potassium.

Fenn⁷ has demonstrated the discharge of potassium from a contracting muscle. On animals the electrical stimulation of a hind limb causes a rise of serum potassium in the outflowing blood which subsides immediately after the stimulation ceases. Under our less favorable although more physiologic experimental conditions this rise is not demonstrable; but we do not doubt its presence. In ischemic exercise the accumulation of free potassium is sufficient for a definite increase of serum potassium even in our experiments.

Dawes⁸ has recently shown that small amounts of potassium chloride (3 to 5 mg.) injected into the femoral artery of an animal produces vasodilatation distally to the site of injection. He discussed the possible role of potassium liberated during muscular exercise as the vasodilator substance for the local active hyperemia of exercise. Larger amounts of potassium injected intra-arterially cause, according to Dawes, a discharge of epinephrine from the adrenal glands, vasoconstriction elsewhere and elevation of blood pressure.

These recent experimental results are much in favor of the role we are inclined to ascribe to potassium: In brief, our hypothesis is that potassium is either the physiologic local vasodilator substance of muscular exercise or is one of a group of substances responsible. When raised to a sufficient concentration it sets off a reflex which results in hypertension. According to Dawes this might be initiated by the discharge of epinephrine. Potassium would, therefore, be of paramount importance in the adjustment of the local and the systemic circulation during exercise. When stored even more, as in ischemic exercise, it irritates the pain receptors of the muscle and is the cause of ischemic pain. A discharge of potassium might take place from cells other than muscle cells when the metabolism is elevated, and potassium might be the cause of ischemic pain elsewhere—although we have no direct proof for such an assumption.

References

1. Lewis, T.; Pickering, G. W., and Rothschild, P.: Observations Upon Muscular Pain in Intermittent Claudication, *Heart* **15**:359 (July) 1931.
2. Maison, G. L.: Studies on Genesis of Ischemic Pain: Influence of Potassium, Lactate and Ammonium Ions, *Am. J. Physiol.* **127**:315 (Sept.) 1939.
3. Rein, H., and Schneider, M.: Die Auswirkung kuenstlicher Mangeldurchblutung auf den lokalen Stoffwechsel, *Arch. f. d. ges. Physiol.* **239**:451, 1937.

4. Hinsey, J. C.: Observations on Innervation of Blood Vessels in Skeletal Muscle, *J. Comp. Neurol.* 47:23 (Dec.) 1928.
5. Kissin, M.: Production of Pain in Exercising Skeletal Muscle During Induced Anoxemia, *J. Clin. Investigation* 13:37 (Jan.) 1934.
6. Weichselbaum, T. E.; Somogyi, M., and Rusk, H. A.: Method for Determination of Small Amounts of Potassium, *J. Biol. Chem.* 132:343 (Jan.) 1940.
7. Noonan, T. R.; Fenn, W. O., and Haege, L.: Distribution of Injected Radioactive Potassium in Rats, *Am. J. Physiol.* 132:474 (March) 1941.
8. Dawes, G. S.: Vaso-Dilator Action of Potassium, *J. Physiol.* 99:224 (Jan. 14) 1941.

NOTE: Discussions will appear in a later issue. — Ed.

TECHNIC FOR REDUCTION AND AMBULATORY TREATMENT OF SACROILIAC DISPLACEMENT *

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One of the most controversial subjects of recent years is the treatment of low back pain, and one of the issues in dispute is the role of sacroiliac displacement in this syndrome. It seems pertinent, therefore, to present at this time the results of an effective method of treatment which we believe sheds light on the etiology of low back pain. We shall describe a manipulative technic for the reduction of sacroiliac displacement developed by the senior author more than thirty years ago. We shall discuss the general management of this condition and present the results in 162 patients treated by this method.

Diagnosis

The clinical picture of sacroiliac displacement has previously been described in many of its details. Our observations indicate, however, that it exhibits such varied aspects as to merit review.

The history usually reveals a sudden or gradual onset of pain in the region of one or both sacroiliac joints. In about 5 per cent of our cases the two joints were displaced simultaneously. The pain is usually worse on the side of the affected joint, but may extend across the sacrum even when only one joint is displaced. The onset is commonly related to some simple motion which combines bending, tilting the pelvis and twisting the trunk, such as a short golf swing, shoveling snow, stooping to pick up an object on the floor or getting up sidewise out of a soft chair. Or the pain may be initiated by a slight fall, pregnancy or general anesthesia. When gradual in onset, the pain becomes progressively worse for a short time, and is then greatly aggravated by some motion of the type mentioned; this type of onset is often preceded by an acute illness or extreme muscular fatigue. Occasionally severe sciatic pain may be the chief symptom of sacroiliac displacement and may so predominate that the patient makes no mention of pain in the back.

Radiation of pain to the lower extremity is extremely frequent and occurred in 44 per cent of our cases. It occurs only on the side of an affected

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joint and is therefore an important guide in some cases. Pain is usually of the referred type; hence there are many variations in the pattern of pain. For instance, pain may be referred to the lumbar region, to the lateral aspect of the thigh, to the gluteal region, to the sacrum or along the iliac crest, as well as to the area of distribution of the sciatic nerve. True sciatic neuritis with sensory changes and loss of deep reflexes occurred in only 3 per cent of our cases.

Limitation of motion is of varying degree. It may wholly incapacitate the patient or be so slight as not to alter his daily routine. The extent of the disability is determined by various factors, including the temperament and reaction of the patient, the amount of muscular spasm and probably the degree of locking out of place of the sacroiliac joint. Acts which cause pain include bending forward, putting on shoes, crossing one leg over the other, rising from a chair and turning over in bed. Limitation of straight leg raising (Goldthwait's or Lasèque's sign) and pain on flexing of the knee against the abdomen (Gaenslen's sign) are usually present on the affected side in severe cases but may be absent in milder ones.

The posture is fairly characteristic. The lumbar curve is flattened and the pelvis is tilted upward on the affected side, causing a prominence of the hip on that side. However, rarely there may be prominence of the hip on the opposite side, probably due to spasm of special muscle groups. The patient walks with a distinct stoop and limps, sparing the leg on the side of the displaced joint. If the pain is slight, posture and gait may be normal.

Tenderness to pressure is always present on the affected side directly over one or both of the posterior iliac spines. This is the most constant single finding, and in its absence we do not make a diagnosis of sacroiliac displacement. Exquisite tenderness to pressure may be present in certain muscles about the joint, especially in the lower end of the erector spinae, in the quadratus lumborum, in the gluteus medius and minimus and in the pyriformis muscle. Pressure on the areas of these muscles is usually much more painful than pressure over the posterior margin of the joint itself. This fact is often a source of confusion leading to a false diagnosis, such as that of "lumbago."

The customary roentgenograms of the pelvis and lumbar spine almost uniformly fail to show any displacement of the sacroiliac joints.

Corkscrew Technic for Reduction

As soon as the diagnosis of sacroiliac displacement is established, we proceed with manipulation by what we shall term the "corkscrew" technic, shown in the accompanying illustration, the details of which are as follows:

The patient lies on the affected side, preferably on a hard table. The leg beneath is hyperextended at the hip with the knee straight; the other leg is allowed to fall into a natural position with the knee slightly bent and the foot hooked loosely over the lower ankle; the arm beneath is drawn forward out of the way at a right angle with the body, and the other arm hangs loosely behind the back.

The operator stands in front of the patient. One hand slightly overlaps the sacrum and grasps the upper ischial tuberosity; the other hand grasps the front of the upper shoulder. Simultaneously the shoulder is pushed backward and the buttock forward and upward, so that the hand on the hip travels in a spiral or corkscrew-like curve. This maneuver causes lordosis of the spine, tilting forward of the upper part of the sacrum and twisting of the body, resulting in a forward rotation of the sacrum on the ilium on which the patient is lying and which is immobilized by the weight of the body.



The maneuver for reduction of displacement of the right sacroiliac joint. Note that the patient is lying on the affected side. Observe the hypertension and rotation of the spine and the forward and upward direction of movement of the uppermost ilium and of the sacrum, which will be still further increased by the final thrust of the maneuver. Note the long "reach" of the operator which enables him to achieve a strong upward push with his right hand.

The force is applied smoothly and steadily without jerks to effect gradual stretching, and when maximum rotation of the trunk is obtained, a quick final thrust is made. Different amounts of force are required for reduction in different cases, but a large reserve of strength is needed in order to perform the manipulation smoothly and to sustain the effort for sufficient time to overcome muscular resistance. Ordinarily the duration of the maneuver is from fifteen to thirty seconds, but longer periods are at times necessary.

A feature essential to successful reduction is muscular relaxation. There are various ways of achieving this. We prefer the static surge^{1, 2} applied over the affected joint for twenty to thirty minutes with the patient lying down. In many cases the use of such physical therapy is not feasible, and relaxation is then sought by allowing a rest period in the recumbent position prior to manipulation, by directing the patient to relax and to breathe deeply through the mouth during the procedure and by sustaining the stretching for several minutes. Sedation may be indicated in some instances, but we have found it necessary to use morphine rarely and general anesthesia in only 1 case.

In most cases manipulation is accompanied by a sound best described as a click or a series of clicks. Also, a sensation is frequently felt in the affected sacroiliac joint. It is important to note that in a small number of cases satisfactory reduction is obtained without an audible click, probably owing to the fact that the parts are moved slowly rather than with a quick "snap." Thus, although the click is apparently indicative of motion in the sacroiliac joint, it is not an essential criterion of reduction. Furthermore, a single click does not necessarily mean that full reduction has been secured; subsequent effort sometimes yields additional sounds. The final click is usually obtained at the extreme limit of stretching on the last forceful thrust. It is desirable to repeat the manipulation until a click ceases to be obtained.

General Management

Ours is an ambulatory type of treatment. We rarely find it necessary to put the patient to bed. We have never applied a plaster cast. We do not use adhesive strapping. As soon after reduction as possible, we encourage the patient to resume his regular routine, provided this does not involve too strenuous physical activity. We emphasize these points because they are in sharp contrast to most methods of therapy now in vogue and because we believe that the chief factors which contribute toward the maintenance of the proper position of the joint are correct posture and normal muscular function.

An important aid to recovery is an elastic belt fitted tightly well below the pelvic crest to constrict the pelvis. We now use a fenestrated rubber belt 6 or 7 inches wide made from an automobile inner tube; the curve of the rubber fits naturally over the upper part of the buttocks and prevents the belt from "riding" upward. The tension of the belt is measured and its length adjusted so that approximately a 10 pound pull is exerted. This belt is quickly and easily made with the aid of a small grommet machine and hence may be applied at once after the first reduction. The patient may wear the belt both day and night for a short period and subsequently during the day for a few weeks.

Other details of management include the use of longitudinal boards beneath a firm mattress for sleeping, the use of a small pillow placed in the "small of the back" when sitting, instructions in posture, both standing and sitting, and instruction regarding the character of motions which tend toward displacement of the sacroiliac joint. In principle the objective is the maintenance at all times of a slightly exaggerated lumbar curve and the avoidance of movements of the body which combine tilting of the pelvis and bending at the waist.

In a certain proportion of cases, a single reduction of the sacroiliac displacement is the only procedure necessary for complete relief of symptoms; this ensues without the use of a firm bed or a belt or attention to any of the details listed. In many cases, however, displacement of the joint for a short time tends to recur readily, and it may be necessary to repeat the manipulation whenever indicated, even daily, during the subsequent week or two. In the latter type of case, the details of general management which we have outlined are especially important.

A complication of sacroiliac displacement requiring special therapy is persistent muscular spasm which provides "trigger points"^{3, 4} with precise areas of referred somatic pain in the back, hip, thigh and leg.^{5, 6} The referred pain may be so severe as to obscure the primary source of trouble in the sacroiliac joint, and it is then not uncommon to find that the only diagnosis which has been made previously is "sciatica." Muscular spasm will not be permanently relieved by any therapy unless reduction of the displaced sacroiliac joint is secured. However, muscular spasm may subside slowly even when normal position of the joint appears to be maintained and may itself be the source of protracted pain. Disappearance of such spasm may be greatly accelerated by physical therapy, especially use of the static surge or the sinusoidal current, which induce rhythmic contraction and relaxation of muscle. In fact, in the presence of this complication, these therapeutic measures may serve not as adjuncts to manipulative treatment but as curative agents in themselves.

Results of Treatment

Table 1 shows the results of treatment by the method outlined in 162 consecutive cases of sacroiliac displacement seen in private practice prior to

TABLE I. — RESULTS OF TREATMENT IN 162 CASES OF SACROILIAC DISPLACEMENT.

Sex	Number of Cases	Total Number of Treated Attacks	Ultimate Result in Percentage of Cases*			
			Complete Relief	Improvement	No Improvement	Unknown
Men	79	99	70.9 (56)	22.8 (18)	1.2 (1)	5.1 (4)
Women	83	116	86.8 (72)	9.6 (8)	2.4 (2)	1.2 (1)
Total	162	215	79.0 (128)	16.0 (26)	1.9 (3)	3.1 (5)

* Figures in parentheses indicate number of cases.

1941. All the patients were white. Approximately half were men and half were women. The 162 patients had a total of 215 attacks of sacroiliac displacement treated by us. The age at which the first attack occurred ranged from eighteen to seventy-nine years; in slightly more than half it was between thirty and fifty years.

The ultimate result in these cases was 79 per cent of the patients cured, 16 per cent improved, 2 per cent unimproved and 3 per cent with the outcome unknown. The percentage of patients cured was appreciably higher for women than for men: 87 per cent and 71 per cent, respectively. This difference is probably due partly to the greater mobility of the female sacroiliac joint demonstrated anatomically^{7,8} and partly to the more severe and persistent muscular spasm in men.

Of the 128 patients cured, half (51 per cent) were followed for one to twenty-eight years, one-third (34 per cent) for one to eleven months and 15 per cent for less than one month.

With respect to the patients improved, 80 per cent were followed for less than one month. It seems highly probable that a considerable proportion of these were actually cured, for some were progressing so well that they were instructed not to return for further treatment unless a relapse occurred. Some received inadequate treatment. Only 5 of this group were treated for three months or more; in 4 of these residual pain was attributed to persistent muscular spasm and in 1 there were partial paralysis and loss of sensation in one leg due to damage to the sciatic nerve which had occurred prior to our treatment.

Regarding the 3 patients unimproved, all had long-standing pain in the back which had been present for an average of thirteen months before treatment. All had severe sciatic pain. All received irregular and inadequate treatment for a period of four days to six weeks.

The 5 patients in whom the outcome was unknown were seen once or were seen twice on successive days and no follow-up was obtained. All had marked sciatic pain.

No undesirable reactions to manipulation were observed other than increased "soreness" about the joint for one or two days afterward in a limited number of cases. Such bony abnormalities as lipping of the vertebrae, sacralization of the fifth lumbar vertebra, the presence of six lumbar vertebrae or Paget's disease of the spine and pelvis did not prohibit manipulation or influence the effectiveness of treatment.

In this study all the patients received treatment, and they cannot be compared, therefore, with a similar group of untreated controls. Although spontaneous replacement at times occurs, in many of our cases the long interval between the onset of sacroiliac displacement and the beginning of treatment establishes an adequate control period. In the cured group, 36 per cent had had disability and pain for one month or longer prior to treatment and 12.5 per cent for six months or longer. These long periods of illness are in sharp contrast to the rapid improvement observed after manipu-

lation; the great majority of patients resumed their normal activities within a few days. Furthermore, in the cases of long-standing illness practically every other method of treatment except surgical intervention had previously been tried; use of diathermy, adhesive strapping, long rest in bed on a fracture board, immobilization by belts, braces and plaster casts, injections of procaine hydrochloride and osteopathic manipulations had all failed.

The reports of 6 typical cases follow:

Case Reports

CASE 1. — Mr. A. R., aged 35, an office manager, in June, 1912, while leaning sidewise from a swivel chair to pick up a paper on the floor, experienced a sudden pain in the lower back so severe that he could not move. When seen fifteen minutes later, he was still sitting in a fixed position leaning forward in the chair. He was given morphine sulfate $\frac{1}{4}$ grain by hypodermic injection and was half carried by two men into a taxi and to our office. Examination revealed signs of displacement of the right sacroiliac joint. The static surge was applied over the region of this joint for thirty minutes with the patient recumbent. Manipulation then resulted in a loud click and immediate relief of pain and disability. The patient walked ten blocks back to his office and continued work without further interruption. He came to the office the following day for a static surge treatment because advised to do so, but had no complaint other than moderate soreness over the joint.

Previously he had had recurrent attacks of "lumbago," but this was the first attack of pain in the sacroiliac region.

Subsequently at long intervals he had a few not disabling recurrences of mild sacroiliac pain promptly relieved by manipulation. These episodes ceased at about the age of 50. During twenty-eight years of observation he has been active, and now, at the age of 63, he plays golf regularly.

This case illustrates the dramatic relief of an acute disabling pain in the sacroiliac region procured within an hour after the onset by manipulation following a static surge treatment. A cure was effected without use of a belt, fracture boards or attention to any of the other details of management.

CASE 2. — Mrs. G. F. B., aged 64, a writer, in March, 1932 while dressing for dinner stooped over and suddenly felt an excruciating pain in the region of the left sacroiliac joint. She was seen by us within fifteen or twenty minutes. The slightest motion caused intense pain, and there was extreme tenderness over the left posterior iliac spines. She was moved with difficulty off the soft bed to the floor. Manipulation was carried out slowly and gently and was painful at first; a click was not heard. Immediate and complete relief from pain and disability resulted. The patient continued dressing at once and entertained guests for dinner without discomfort. During the following month she received several static surge treatments because of the complaint of "soreness" about the joint; she had no restriction of motion and continued her regular activities during this time. This was the first attack of its kind. She has had no further trouble with her back during the past nine years.

In this case a spectacular result was obtained by manipulation without sedation employed as emergency treatment within a few minutes after the onset of severe back pain.

CASE 3. — Mrs. F. E. M., aged 64, a housewife, in May, 1936 while stooping to push a sliding door suddenly felt a sharp pain in the left lower back, radiating down the back of the left leg to the foot. She was completely disabled and spent the ensuing three weeks in bed, without improvement. The chief complaint was severe pain in the leg and the diagnosis was "sciatica." The only treatment was the application of a liniment. At the end of three weeks she walked with difficulty and had to be assisted into our office. There was marked restriction of motion of the back, and tenderness on the left side over the posterior iliac spines and in the gluteal and lower lumbar muscles. There were no neurologic changes. The static wave was applied over the region of the left sacroiliac joint for one-half hour with the patient recumbent. Manipulation then produced a loud click and complete relief of pain and disability. Subsequently there was residual "soreness" over the joint. No further treatment was given, and the patient had no further trouble with her back during the subsequent four years of observation. This was the first attack of back pain.

In this case complete disability for three weeks preceded immediate relief secured by manipulation after a static surge treatment. Owing to radiation of pain to the leg the previous diagnosis was "sciatica." This case closely parallels the preceding one with respect to sex, age, type of onset, degree of disability and

singleness of the attack. The striking difference between the two is the duration of disability: a few minutes in the former, and three weeks in the latter owing to delay in the application of manipulative treatment.

CASE 4.—N. K., aged 35, a physician, in March 1939, when bending over a bed to examine a patient, felt a sharp pain in the region of the left sacroiliac joint and had to hold onto the bed to prevent falling. After sitting down for twenty minutes, he was assisted to his car and managed to drive home but had to lift the left leg onto the clutch with his hands. He went to bed, the back was strapped with adhesive tape and heat was applied locally. He remained in bed but could not obtain relief from pain in any position.

Forty-eight hours after the injury when seen at his home, he got onto the floor with difficulty by rolling off the bed. He could not walk without support and almost any movement was painful. The signs were those of left sacroiliac displacement with very little muscle spasm. Manipulation was carried out without obtaining an audible click. Immediately the patient got up, walked about, bent forward with knees straight and put both hands on the floor, and had no pain or limitation of motion. He proceeded with his usual work. During the ensuing week he complained twice of a "catch" in his back and manipulation was repeated in each instance with entire relief. Tenderness to pressure over the left posterior iliac spines persisted for about two weeks. This was the first attack of its kind.

Two years later a second attack of back pain occurred which was much less severe. The onset was gradual after lifting a baby and was characterized by sharp pain in the left sacroiliac joint which became progressively worse for four or five days while the patient continued at work. There was then tenderness over the left posterior iliac spines and no limitation of motion except on bending. The patient walked without a limp. Manipulation was carried out on four occasions during the following three weeks, and each time was accompanied by an audible click and relief of pain. Boards were placed beneath the mattress. Since the last manipulation there has been no back pain.

This case illustrates the apparently miraculous restoration of normal function in a completely disabled patient by means of manipulation 48 hours after the onset of back pain. It is of interest that both the severe and mild forms of sacroiliac displacement were manifested in the same person at different times; the former responded to treatment more rapidly than the latter. Reduction in the first instance was accomplished without an audible click.

CASE 5.—Mrs. S. O., aged 39, a trained nurse, in November 1939, while on duty in the hospital slipped and fell landing on the coccyx. Immediately an excruciating pain across the lower back and in the right leg was felt. Roentgenograms of the pelvis and lumbar spine were taken at once and proved negative. The back was strapped. She remained in bed for four weeks. During this time she received several injections of procaine in the right lumbosacral region which afforded temporary relief of pain. Four weeks after the accident she returned to work although suffering a great deal of pain. She could not walk upstairs at all and moved to a friend's apartment where there were no steps to climb.

She was first seen by us five weeks after the injury, and three days after the last procaine injection. She walked with a marked limp, sparing the right leg. Motion of the spine was limited, especially flexion. There was tenderness over the right posterior iliac spines and also over the coccyx. Manipulation was carried out slowly and was painful at the outset; the final thrust was accompanied by a loud grating sound audible throughout the room. The patient got up at once and had regained perfect motion; she could walk, run, climb stairs and bend forward freely. She continued at work without pain although some tenderness over the sacroiliac joint and coccyx persisted for about three weeks. This was the first attack of back pain.

About four and one-half months after the injury there was a recurrence following a misstep. The pain was again in the right sacroiliac region and of about the same severity. When seen six hours after the onset, the signs were similar to those noted in the first attack. Manipulation was carried out as before with complete relief, although on this occasion an audible click was not obtained. The subsequent course was similar to that of the first attack. There has been no recurrence of symptoms.

In this case, manipulation in the first attack secured complete relief of pain and disability after a "control period" of five weeks between the onset and treatment. In a second similar attack of sacroiliac displacement the early application of manipulative treatment shortened the period of disability to a few hours. This case also demonstrates that an audible click is not a necessary attribute of successful reduction.

CASE 6.—Mrs. C. K., aged 47, a housewife, in July 1940, following a long automobile ride the patient experienced pain across the lower back, which became gradually worse the

next week. She managed to carry on her work about the house, although she was in great discomfort and for a while could barely put on her shoes. Rising from a chair, getting out of bed and bending forward caused diffuse pain low in the back. At times there was mild radiation of pain to the left leg.

Three weeks after the onset, when we saw her, there had been some improvement. At this time the only motion which was limited was bending at the waist. The patient walked without a limp, but there was a marked shift of the hips to the right. The patient could not say whether the pain was greater on the right or the left; there was no complaint of pain in the lower extremities. Moderate tenderness to pressure was present over the left posterior iliac spines and also in the lumbar and calf muscles on both sides, but to a greater degree on the left than the right. The straight-leg raising test was positive on the left side only. Manipulation of the left sacroiliac joint was accompanied on the first attempt by a loud click. Afterward the patient was much relieved and bending forward was less restricted; the shift of the hips to the right was unchanged. A pelvic belt was supplied and boards were placed beneath the mattress. The patient was instructed in posture and in the nature of the movements which tend toward displacement of the sacroiliac joint. Two days later the patient drove twenty-five miles and walked a long distance without discomfort. A week later she left on a camping trip. Her husband, a doctor, was practiced in the maneuver for reduction and reported that a few days after their departure she complained of slight pain in the region of the left sacroiliac joint, which was relieved promptly by a single manipulation. There has been no recurrence of back pain during more than a year.

This was the sixth attack of sacroiliac trouble in less than two years. Each began gradually when the patient was excessively fatigued. Each lasted for three to four weeks and subsided gradually; treatment had consisted of rest in bed, adhesive strapping and the application of heat. The attacks occurred in September 1938, December 1938, April 1939, September 1939, December 1939 and July 1940, respectively. The last was the worst. Altogether the patient had been partially disabled for about five of the preceding twenty-three months.

In spite of the history of frequent recurrences, a successful result was achieved in this case of manipulation and by attention to preventive measures. This is the type often selected for surgical fusion of the sacroiliac joint, owing to the failure of the usual conservative methods of treatment. It is noteworthy that reduction was obtained by our manipulative procedure even though the displacement was accompanied by an unusual type of deformity.

Comment

The conception that sacroiliac displacement may be a cause of backache is not new. Displacement of this joint was described clinically as long ago as 1870 by Snelling⁹ and was comprehensively redescribed by Goldthwait and Osgood in 1905.¹⁰ This condition has since been recognized by other observers.^{11, 12, 13, 14, 15, 16, 17}

A perusal of the literature reveals, however, that this condition is not recognized generally as an etiologic factor in back pain, if indeed its existence as a clinical entity is admitted at all. Pain in the region of the sacroiliac joint is apt to be attributed to ligamentous tears; to traumatic, arthritic or inflammatory changes in the joint surfaces; to "relaxation" of the joint, or to coincidental anomalies of the spine or pelvis.^{18, 19, 20, 21, 22, 23} In our experience sacroiliac displacement, as indicated by the location of pain and tenderness and by the results of manipulation, has been the major cause of low back pain as well as of radiation of pain to the lower extremity. It seems to us that the importance of sacroiliac displacement as a cause of these symptoms can scarcely be overemphasized.

What then are some of the objections to this conception of sacroiliac displacement as a primary cause of low back pain?

In the first place, roentgen examination almost always fails to visualize any such displacement. Roentgenograms are of course desirable to exclude certain other conditions, but proof of displacement is certainly lacking when roentgenograms are taken in the usual manner with the patient recumbent. However, some roentgenologists have indicated that these displacements can be demonstrated by special technics.^{13, 24} The explanation for the general lack

of convincing roentgenologic evidence probably lies in the complexity of the joint planes and the small range of motion in the sacroiliac joint. Conclusions based on roentgen examination of this joint are notably unreliable, for it has been shown that even complete ankylosis cannot be diagnosed by roentgenograms taken at various angles.²⁵ Furthermore, it has been demonstrated that motion in this joint is not in a vertical plane but rotary around a transverse axis.^{10, 11, 15, 26} One would not anticipate that such a shift in position could be detected by the customary roentgenograms.

Pathologic studies are of no more aid than roentgenograms for the reason that postmortem examination of the displaced joint is rarely available.

This lack of precise information as to the exact nature of sacroiliac displacement is a serious obstacle to recognition. Schunke,²⁷ however, has made the pertinent observation not only that there are wide variations in size, shape and contour of the sacroiliac joint but that supernumerary articular facets are present in 36 per cent of the cadavers examined. Schunke concluded:

To dislocate a fair-sized eminence from its apposed depression would require a considerable amplitude of motion, but since supernumerary facets sometimes are merely tiny elevations or tubercles, only slight motion would be required to dislocate them or other slight irregularities upon the articular surfaces. Tension of the interosseous ligaments would tend to keep such prominences dislocated and resist the separation necessary for their relocation, though they might be made to "snap" back into position by more or less strenuous manipulation.

Still another obstacle is the fixed idea of the medical profession that manipulation of the back is irrational and unethical. Pitkin¹⁷ has said: "Manipulative surgery is a therapeutic waif of lowly origin whose infancy and childhood have been shielded from the light of reason by a congenital veil of empiricism and quackery." Those who do recognize the value of manipulation as a rule employ an indiscriminate variety of manipulative procedures often requiring general anesthesia, or they may proceed with manipulation only as a last resort after other methods have failed.^{14, 15, 16, 18, 20, 23, 28, 29, 30} A recent expression of this point of view is as follows:²³

Many authorities believe that there is a definite place for manipulative procedures in the treatment of pain low in the back. No manipulation or operative procedure should be done until conservative treatment has been tried for two or three weeks, and not then until there is no evidence of lesions of the back, such as a fracture or congenital anomaly. If after adequate rest, heat, massage, etc. (for two or three weeks) there is still fixed lordosis in the lumbar region and the straight leg-raising test is positive, manipulation with the patient under gas anesthesia may be done for the purpose of stretching the tight muscles and fascia of the lower part of the back.

Our contribution to the problem is the development of a simple, safe and effective technic for reduction which does not require general anesthesia, which may be used as the first therapeutic measure and which yields satisfying results in the hands of the qualified physician after moderate experience with it.

It is true that reduction of sacroiliac displacements may be secured by other manipulative technics reported in the literature. These manipulations include a number of procedures which produce flexion and hyperextension of the spine and a simple forward and backward movement of the upper part of the sacrum on the iliac bones.^{15, 16, 29, 31, 32} In addition, certain procedures combining rotation of the spine and iliac torsion have been employed. Gilcreest³² carries out this maneuver routinely with the patient lying first on one side and then on the other. Burrows and Coltar²⁹ and also Gray¹⁵ indicated that the affected joint should be placed uppermost. Pitkin¹⁷ did not make a direct statement on this point but indicated that the statistical probabilities as to the direction of displacement, as judged by the character of the deformity, "show that any type of sacroiliac slip is reduced more fre-

quently in the inferior than in the superior position." We have experimented with the Pitkin and similar technics and find that when an affected sacroiliac joint is placed uppermost the pain may be markedly increased; when the patient lies on the affected side the effect is in some respects similar to that produced by our technic.

A number of important differences distinguish our manipulative procedure from others reported. In our maneuver the patient always lies on the affected side. With the patient in this position, the Pitkin and similar maneuvers force the uppermost ilium downward, whereas ours forces it upward together with a corkscrew-like rotation of the sacrum on the ilium. We manipulate only that sacroiliac joint which is affected. We employ a single type of manipulation rather than a variety of such procedures. The effectiveness of our technic has convinced us that practically all sacroiliac displacements occur in one direction regardless of the type of deformity and that the use of various manipulations is uncalled for. In our experience this technic almost always secures reduction, and the fact that certain patients in our series are classified as not cured is due in most instances to the presence of complicating muscular disorder, to recurrence of the displacement with inadequate treatment or to an inadequate period of observation.

The application of our technic for reduction affords what may be called a therapeutic test for displacement of the sacroiliac joint. In the absence of more objective proof, it is the chief evidence for the existence of this condition as a clinical entity and as an important cause of back pain. Certainly the effect of manipulation is similar to that which follows reduction of dislocations elsewhere in the body. It is inconceivable that the immediate, dramatic relief of pain and disability obtainable by such manipulation could be due to anything other than the restoration of joint surfaces to their normal relation.

Summary and Conclusions

1. A technic is described for the reduction of displacement of the sacroiliac joint without general anesthesia, and the details of an ambulatory method of treatment of this condition are presented.
2. In 162 cases of sacroiliac displacement treated by this method, 79 per cent of the patients were cured, 16 per cent were improved, and 2 per cent were unimproved, and in 3 per cent of the cases the outcome was unknown. The results were better for women than for men.
3. Variations in the clinical pattern and some complications of sacroiliac displacement are indicated.
4. The results of treatment indicate that displacement of the sacroiliac joint is an important factor in the causation of low back pain.
5. The results also indicate that the early application of manipulative therapy shortens the period of disability.
6. The uniformity with which reduction is secured by a single manipulative technic suggests that displacements of the sacroiliac joint occur in only one direction.

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References

1. Travell, W.: The Static Wire Brush Discharge and the Static Surge, Amer. J. Electrotherapeut. & Radiol. **41**:6 (Jan.) 1923.
2. Travell, W., and Travell, J.: Modifications and Effects of the Static Surge and of the Wire Brush Discharge, Arch. Phys. Therapy **22**:486 (Aug.) 1941.
3. Steindler, A., and Luck, J. V.: Differential Diagnosis of Pain Low in the Back, J. A. M. A. **110**:106 (Jan. 8) 1938.
4. Steindler, A.: The Interpretation of Sciatic Radiation and the Syndrome of Low-Back Pain, J. Bone & Joint Surg. **22**:28 (Jan.) 1940.

5. Kellgren, J. H.: Observations on Referred Pain Arising from Muscle, *Clin. Sc.* **3**:175 (April 28) 1938.
6. Kellgren, J. H.: On the Distribution of Pain Arising from Deep Somatic Structures with Charts of Segmental Pain Areas, *Clin. Sc.* **4**:35 (June) 1939.
7. Brooke, R.: The Sacro-Iliac Joint, *J. Anat.* **58**:299 (July) 1924.
8. Sashin, D.: A Critical Analysis of the Anatomy and the Pathologic Changes of the Sacro-Iliac Joints, *J. Bone & Joint Surg.* **12**:891 (Oct.) 1930.
9. Snelling, G.: Relaxation of the Pelvic Symphyses During Pregnancy and Parturition, *Am. J. Obst. & Gynec.* **2**:561 (Feb.) 1870.
10. Goldthwait, J. E., and Osgood, R. B.: A Consideration of the Pelvic Articulation from an Anatomical, Pathological and Clinical Standpoint, *Boston M. & S. J.* **152**:593 (May 18) 1905.
11. Albee, H.: A Study of the Anatomy and the Clinical Importance of the Sacro-Iliac Joint, *J. A. M. A.* **53**:1273 (Oct.) 1939.
12. Cyriax, E.: Minor Displacements of the Sacro-Iliac Joints, *Brit. J. Phys. Med.* **8**:191 (April) 1934.
13. Chamberlain, W. E.: The Symphysis Pubis in the Roentgen Examination of the Sacroiliac Joint, *Am. J. Roentgenol.* **24**:621 (Dec.) 1930.
14. Galland, W. I.: Low Back Pain, *Arch. Phys. Therapy* **18**:16 (Jan.) 1937.
15. Gray, H.: Sacroiliac Joint Pain: The Finer Anatomy; Mobility and Axes of Rotation; Etiology, Diagnosis and Treatment by Manipulation, *Internat. Clin.* **2**:54 (June) 1938.
16. Littlejohn, C. W. B.: Traumatic Lesions of the Sacro-Iliac and Lumbo-Sacral Joints, *M. J. Australia* **25**:771 (April 30) 1938.
17. Pitkin, H. C.: Sacroarthrogenetic Telalgia. V. A Plan for Treatment, *J. Bone & Joint Surg.* **19**:169 (Jan.) 1937.
18. Baer, W. S.: Sacro-Iliac Strain, *Bull. Johns Hopkins Hosp.* **28**:159 (May) 1917.
19. Gaenslen, F. J.: Sacro-Iliac Arthrodesis, *J. A. M. A.* **89**:2031 (Dec. 10) 1927.
20. Freiberg, J. A.: Low Back Pain, *J. A. M. A.* **113**:2195 (Dec. 16) 1939.
21. Mitchell, J. I.: Surgical Treatment of Affections of the Lumbosacral and Sacroiliac Joints, *Surgery* **4**:33 (July) 1938.
22. Lissack, E.: Backache During Pregnancy and Its Management, *J. Missouri M. A.* **37**:238 (June) 1940.
23. Girard, P. M.: Low Back Disabilities, *Arch. Phys. Therapy* **22**:410 (July) 1941.
24. Trostler, I. S.: Slipping Sacro-iliac Joints, *Radiology* **31**:363 (Sept.) 1938.
25. Horowitz, T., and Smith, R. M.: An Anatomical, Pathological and Roentgenological Study of the Intervertebral Joints of the Lumbar Spine and of the Sacroiliac Joints, *Am. J. Roentgenol.* **43**:173 (Feb.) 1940.
26. Pitkin, H. C., and Pheasant, H. C.: Sacroarthrogenetic Telalgia. II. A Study of Sacral Mobility, *J. Bone & Joint Surg.* **18**:365 (April) 1936.
27. Schunke, G. B.: The Anatomy and Development of the Sacro-Iliac Joint in Man, *Anat. Rec.* **72**:313 (Nov.) 1938.
28. Bankart, A. S. B.: The Use and Abuse of Manipulative Surgery, *Brit. Med. J.* **2:416** (Aug. 29) 1936.
29. Burrows, H., and Coltart, W. D.: Treatment by Manipulation, The Practitioner Booklets, London, Eyre and Spottiswoode, 1939, p. 26.
30. Bell, B. T.: The Diagnosis and Treatment of Low Back Pain, *M. Clin. North America* **25**:1755 (Nov.) 1940.
31. Barker, H.: Manipulative Surgery, *Brit. M. J.* **2**:255 (Aug. 1) 1936.
32. Gilcreest, E. I.: Lumbosacral and Sacroiliac Strain Causing Low Back Pain, *Ann. Surg.* **107**:988 (June) 1938.

Discussion

Dr. Henry Ullrich (Baltimore): Certainly, this is a controversial subject. As one who has been brought up in a school of thought that most of these sacroiliac pains are due to lumbosacral abnormalities, I was impressed by the rapidity with which Dr. Travell has cured some of these patients. So impressed was I that last Wednesday a patient came into my office and I thought I would try it on him. I gave him that quick upward thrust and he felt the click and I felt the pain in my back. Nevertheless, the patient was in this morning and it has been now about five days and he still feels pretty well.

This subject, as you know, has gone through the entire gamut of things, but certainly the sacroiliac joint has outlived the rest of them. The lumbosacral joint has been attacked many times by surgery, the fascia lata has been attacked, the ligamenta flava has been attacked, so have the intervertebral disks. The end results of those are surprisingly alike; they are all in the seventies as far as percentages go. End results for successful lumbosacral fusions run about 72 per cent; end results for similar groups of patients in which sacroiliac fusions have been done, run into the seventies, and in preparing a

group of patients done, Dr. McCracken some months ago, analyzed about 28 patients who had the so-called herniated disk syndrome, and compared them with a similar group of patients who had the same picture but did not have the disk syndrome but had had lumbosacral fusion, about an equal number of those two groups got well. So whatever the cause of this low back and sacroiliac pain, certainly none of those can match the rapidity with which these patients get relief by Dr. Travell's maneuver.

We think about what may cause pain and what may not cause pain. As a matter of fact, none of us have ever seen inside of a sprained ankle, so we are just talking about probabilities and possibilities. When we operate upon these patients we don't see very much to account for the severe pain of which many of these patients complain. For some reason or other some of them get well, regardless of the etiology of these pains, whether we believe it to be sacroiliac displacement or not, certainly none of these procedures that we have mentioned before can duplicate what this corkscrew maneuver of Dr. Travell's has done.

Dr. Francis W. Glenn (Miami, Fla.): There are two features in this presentation that may be emphasized. The first is that of reaching a definite diagnosis before treatment is started. The problem of making a diagnosis in low back pain can be difficult. Low back pain is one of the curses of man since he assumed the erect posture which changed the lumbar curve from a kyphosis to a lordosis and placed a shearing strain at the lumbosacral and sacroiliac joints because of the superincumbent weight of the trunk, of the upper extremities and of the head. More anatomic variations exist in the lumbosacral and sacroiliac joints than exist in all of the other areas of the spine combined, a fact which is not generally appreciated. The stress and the strain in this area of the back are tremendous. Nature has tried to accommodate for these variations by the strengthening of the supporting ligaments and muscles and by the bowing posteriorly of the ribs near their vertebral junctions to permit a better mechanical lever for muscular attachment between the pelvis and the chest cage and dorsal part of the spine. This in turn may be excessive and tend to increase the angle of the sacrum to a more horizontal position and thus add more stress at the sacroiliac joints and on the lumbosacral and lower lumbar articular facets.

The term congenital anomalies has been used for these variations but they have been found so frequently that it is difficult to designate a definite normal. Nevertheless these variations, which may be unilateral or bilateral, may permit excessive strain and thus cause pain. The effusion in the joints can rarely ever be felt because of their location. Good roentgenograms taken in the various planes, antero-posterior, lateral and right and left obliques are essential for a more critical

diagnosis. These observations should be correlated with the clinical history and the physical findings. A "snap" diagnosis is definitely to be avoided.

The second important feature in this presentation is the use of manipulation which the authors have used judiciously and with a thorough knowledge of the structures. Manipulation of the spine has fallen into disrepute with the medical profession before many of us have learned to use it. The reason is obvious, but the fact that quacks and cults use manipulation is no pathognomonic sign that it does not have a place in physical medicine. Manipulation can be harmful just as any other medical or surgical procedure can be, if used indiscriminately.

Manipulation under an anesthetic is probably the most dangerous but is generally the least feared procedure. This procedure should be used only if other measures fail and if it is known that no harm will result. The use of too much force is to be condemned. Many cases of referred pain are cured by manipulation and credit is given to the manipulator for the cure of angina pectoris, disease of the gallbladder, ulcers of the stomach, appendicitis and cancer, which were, of course, not the true diagnoses. But—the patient was relieved of pain and that was real to him. This can not be too strongly emphasized.

In selected cases the results of manipulative therapy are gratifying. It belongs in organized medicine and it is up to us as physicians to recognize it and use it intelligently.

Dr. Frank Ober (Boston): The symptoms that Dr. Travell is pointing out are the same as for any low back condition. It must be remembered that one has pain in the lower part of the back because it is a back, and that there are numerous conditions which will give the same symptoms. In fact, you may have symptoms of pain in the low back without any limitation of motion whatever, and there may also be a sciatica in such a lame back. These same symptoms occur in arthritis, in ruptured disks, ruptured nucleus pulposis, lateral curvature of the spine, too much lordosis, decreased lumbar lordosis. In the lesion of the sacroiliac joint the one symptom which stands out is that of localized pain over the sacroiliac joint. The examiner must be sure he is over the sacroiliac and not localizing pain at some distant point over the gluteal region.

The common diagnosis of low back conditions for years has been dislocated sacroiliac joint or strained sacroiliac joint. The word "sacroiliac" rolls off the patient's tongue rather fancifully and impresses his friends with the seriousness of the trouble that is present.

About seventy per cent of the backs which appear in our clinic have been through the hands of manipulative surgeons; some for many times and over many years. These backs do not seem permanently cured.

A true dislocation of the sacroiliac joint is probably very rare in men. It may occur more frequently in women as a result of pregnancy, but nature usually takes care of the pregnant woman's sacroiliac joint by tightening up her sacroiliac ligaments in a natural fashion.

With regard to the maneuver which has been demonstrated by Dr. Travell, it seems to me that the one thing that happens is that these maneuvers relieve muscle spasm. It would seem to me to be impossible to expect such a maneuver as this to reduce a sacroiliac joint without an anesthetic. I do not see how sudden relief of pain can occur except by relieving muscle spasm which restores the normal physiologic curves of the spine.

Fortunately for the medical profession it is becoming more and more apparent that the diagnosis of sacroiliac trouble is on the decrease, since there are so many other conditions which have been discovered over the past twenty or twenty-five years which account for pain in the sciatic nerve. I do not mean to say that strain or sprain of the sacroiliac joint never occurs or that other conditions never occur in the sacroiliac joint, because they do. However, except in one or two instances, I have never seen a manifest dislocation of the sacroiliac joint in a man.

Dr. K. G. Hansson (New York, N. Y.): As has already been said, the subject for discussion is open to a great deal of controversial opinions. I agree with Dr. Travell that in many instances some form of manipulation will relieve a certain number of patients. I know, and most of you know, that other forms of treatment will relieve about the same percentage of symptoms. Therefore, I believe that we are not yet on the right track in the treatment of low back pain.

I think, as Dr. Ober said, that the opinion at the present time that most low back pain is connected with the sacroiliac joint is disappearing gradually. I think it is dangerous to discuss treatment of low back pain without a careful diagnosis of the pathologic changes. I always like to divide low back pains into 5 groups and to base the treatment accordingly. I think we have a definite evidence for the first group, which consists of the muscular strain, a slight tear of the muscle fibers; the second group I think has to do with an unstable fifth lumbar and its variations; third, we have low back pain conditions due to unbalanced muscle power; fourth, we have a group of cases of arthritis or pre-clinical signs of arthritis; and then, finally, we have a fifth group including a nucleus pulposus rupture.

I believe unless we base our treatment on the proper classification and diagnosis, our treatment will never be very satisfactory.

I was very glad to hear the paper of Dr. Travell because I thought it might have something to offer us, but I would like to place treatment as presented on the

proper diagnosis before I apply it to every low back pain. I think Dr. Travell started from the diagnosis of the sacroiliac pathology, and I think if that is true, the paper is worth while and the treatment will prove beneficial many times.

Dr. Frank H. Krusen (Rochester, Minn.): No less an authority than the late Willis Campbell of Tennessee said that he had examined thousands of backs in health and disease and had never seen a subluxation of the sacroiliac joint or displacement of such a joint except occasionally following pregnancy or after extremely severe trauma. There are many angles to this question.

Dr. Glenn's closing remarks remind me of the comment of Ambroise Paré the great barber-surgeon: "I dressed him and the Lord healed him." I don't mean to imply that the work of the Drs. Travell falls in that category, but we have got to evaluate such things and see how much we do and how much the Lord does.

It struck me that the manipulation Dr. Travell has been using is somewhat similar to one that Dr. Mennell of England has described, with the exception that although there is a rotary motion there is not the upward thrust. I would like her to discuss the difference between the two manipulations.

Dr. Frank H. Ewerhardt (St. Louis, Mo.): This subject is interesting and timely. I would like to point out two observations which are pertinent to it. One is that members of the medical profession do not hesitate to manipulate a dislocated neck but look askance on the same procedure with respect to the lower part of the back.

It is the general belief in orthopedic circles that what we usually call a sacroiliac displacement cannot be a dislocation in the sense that other joints are dislocated, and that roentgenographic observations have verified this conclusion. I would like to site a case bearing on this point. A young lady with an acute condition of the lower back and with the right leg one inch shorter than the left, was placed on the x-ray table, a plate was taken, the patient was manipulated and again a plate was made. On examination it was impossible to tell which plate was taken first, clearly showing that there could not have been a dislocation. The shortening obviously was owing to an acute muscular spasm.

We do not believe that one particular manipulation fills the need of all. A number of technics have been published and we have used them all and have frequently found that the simple procedure of circumducting the thigh during the course of the examination relieves the condition. Dr. Travell's technic seems logical and we certainly shall try it.

Dr. Janet Travell (closing): I cannot cover all the points that have been raised, but I want to say that I am in complete agreement with most of them.

ARCHIVES of PHYSICAL THERAPY

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL THERAPY

∴ EDITORIALS ∴

FEVER THERAPY

The value of fever therapy in the treatment of certain infections is now well established. *Treponema pallidum*, the gonococcus and the meningococcus are susceptible to temperatures which the human body will tolerate. Bessemens¹ showed a temperature of 104 F. for two hours *in vitro* to be lethal for the spirochete of syphilis. In a similar study on the same organism Boak, Carpenter and Warren² found a temperature of 105.8 F. for one hour to be lethal. Carpenter and Boak,³ in an investigation of 250 different strains of the gonococcus isolated from patients, found the thermal death time at 106.7 F. to vary from six to thirty-hour hours, average sixteen and one-tenth hours.

Most other infecting organisms are not susceptible to temperatures which the human body will tolerate. Fortunately, however, the direct lethal action of temperature elevation on bacteria is not the only mechanism at work in combating infections. The defense mechanisms of the body are stimulated by fever. An example of this is the marked increase in the polymorphonuclear cells of the blood. We find artificial fever, therefore, of value in undulant fever, Sydenham's chorea, rheumatic fever, rheumatoid arthritis and ocular infections. It is not unlikely that other infectious diseases may later be found to respond favorably to this method of treatment.

White⁴ demonstrated that *in vitro* a rise of temperature from 37 to 39 C. (98.6 to 102.2 F.) resulted in a one hundred fold increase in the bactericidal potency of sulfanilimide and sulfapyridine. Ballenger, Elder and McDonald⁵ were the first to report the combination of sulfanilimide and fever therapy in the treatment of gonorrhea. Trautman,⁶ in a recent article describing his experience in the use of fever and the sulfonamides in the treatment of gonorrhea in the male, has shown that the combination of fever and the sulfonamides, especially sulfathiazole, is far superior to either one alone. A number of other investigators have obtained similar results. Lichtenman and Bierman⁷ have recently announced recovery in 4 (16 per cent) of 24 patients with subacute bacterial endocarditis by a combination of sulfonamide and artificial fever. This is also effective therapy in acute brucellosis. In any infection when it may seem desirable to enhance the bactericidal potency of sulfonamide, fever therapy is a logical procedure.

In this issue of the ARCHIVES, there appears an article by Trautman setting forth his experience in the administration of 6,881 artificial fever sessions in 1,200 cases of gonorrhea, neurosyphilis, ocular disease and the chronic arthritides. The author has described his routine technic, has tabulated his complications and has described the postmortem findings in his single fatality. These last are especially instructive since they represent a more or less typical picture of the pathologic changes found in animals and in humans who have died as the result of fever therapy. The author has called attention to the fact that there have been no deaths in his series in the past five years. The improvement in the technic of fever therapy during

this time has rendered the procedure relatively safe when done in a hospital by trained personnel.

References

1. Bessemens, A.: Fever Therapy, Abstracts and Discussions of Papers Presented at the First International Conference on Fever Therapy, New York, Paul B. Hoeber, Inc., 1937.
2. Boak, Ruth A., and Carpenter, C. M. (*Ibid.*).
3. Carpenter, C. M.; Boak, Ruth A., and Warren, S. L.: Abstracts of Papers and Discussions, Fifth Annual Fever Conference, 1935.
4. White, H. J.: The Relationship Between Temperature and the Streptococcal Activity of Sulfanilimide and Sulfapyridine in Vitro, *J. Bact.* **38**:549 (Nov.) 1937.
5. Ballenger, E. G.; Elder, O. F., and McDonald, H. P.: Sulfanilimide and Thermootherapy in Gonococcal Infections, *J. A. M. A.* **109**:1037 (Sept. 25) 1937.
6. Trautman, J. A.: Sulfonamides and Fever Therapy in the Treatment of Gonorrhea in the Male, *Ven. Dis. Infor.* **23**:51 (Feb.) 1942.
7. Lichtman, S. S., and Bierman, William: The Treatment of Subacute Bacterial Endocarditis, *J. A. M. A.* **116**:286 (Jan. 25) 1941.

THE TWENTY-FIRST ANNUAL CONVENTION IN PITTSBURGH

Physical therapy is of vital importance in the great task of rehabilitation of the injured fighting men and also on the civilian and industrial front. Because of this, important plans for the annual convention are steadily progressing. Note the change of time of the convention. The program begins Wednesday, September 9, and ends Saturday noon, September 12. Saturday afternoon will be devoted to visits to various physical therapy departments in and near Pittsburgh.

An excellent program is being developed which will be of interest and importance to every practicing physician. A new feature this year will be actual demonstrations during the regular sessions.

The seminar instruction course has become a part of the annual convention and in this issue of the *ARCHIVES* is presented the nearly completed outline of the course.

Several new features will be introduced to make the instruction courses more interesting and valuable. One period of one and a half hours will be devoted to a round table discussion which will be open to everyone registered for the course. Such subjects as physical therapy in war, backache and poliomyelitis will be discussed and also subjects brought up by the participants. Another feature will be a one and a half hour period of lecture and demonstration which should prove invaluable to those attending.

The instruction course will be given three days—September 9, 10 and 11. Nine lectures, one of which will be the round table, are given for \$15.00. Each section will be limited; therefore, it is important to make your reservations early by writing to the American Congress of Physical Therapy, 30 North Michigan Avenue, Chicago, Illinois.

SURGERY AND PHYSICAL THERAPY IN THE CARE OF THE WOUNDED

Moorhead¹ has recently recounted his surgical experiences in the care of the wounded in Hawaii following the attack at Pearl Harbor. It so happened that he was in Honolulu at the invitation of the local medical society to give a series of lectures on "Traumatic Surgery." Thirty-six hours before the attack he delivered an address on "Treatment of Wounds, Civil and Military." The recommended treatment was: (1) thorough early cleansing with soap and water, (2) débridement, (3) absolute hemostasis, (4) local

application of sulfanilimide or sulfathiazole, (5) no suturing, wounds left wide open, (6) heavy gauze dressing and splintage as indicated, (7) a sulfonamide drug 1 Gm. every four hours by mouth, (8) necessary sedation, (9) no redressing for forty-eight to seventy-two hours unless indicated.

A few hours later this program was instituted in actual practice when the wounded began to pour into the hospitals. The results were highly satisfactory. The postoperative mortality was 3.8 per cent. There was no tetanus and, although there were several cases of gas gangrene, there were no deaths. Purulent discharge was almost absent. Dr. Moorhead said in summary, "The results were better than I had seen during nineteen months in France when serving with French, Belgian and American medical formations."

In the ultimate rehabilitation of these wounded men, physical therapy will certainly play a prominent role. If physical therapy physicians and technicians perform as brilliantly as the surgeons have already done, the best possible end results are assured. The early application of an appropriate form of heat followed by the skilful use of massage and exercise will add greatly to the comfort and morale of these patients and will definitely lessen the convalescent period. Physical therapy has made much progress since World War I, and we may therefore, expect to see even better results follow its use in the present emergency.

Reference

1. Moorhead, John J.: Surgical Experience at Pearl Harbor, *J. A. M. A.* **118**: 712 (Feb. 28) 1942.

THE PHYSIOLOGIC ACTION OF PHYSICAL AGENTS

Empiricism in therapeutics arises from a lack of understanding of the response of physiologic processes to therapeutic agents. Only by careful fundamental studies in chemical, physical, physiologic and pharmacologic research laboratories can therapeutic empiricism be reduced to a minimum. In the past forty years, much has been accomplished in rationalizing drug therapy through research in pharmacodynamics. As a result of this research, numerous pet drugs have been shown to be of little or no value and many other new and important substances have been discovered. The same thing needs to be done for physical therapy, and, in fact, is being done. Here too, some cherished procedures have been discarded and other new ones developed. Fundamental research on the physiologic action and effects of physical agents is a needy and interesting field. Empiricism in physical therapy will disappear before its revealing scrutiny.

The meaning of fundamental research in physical therapy is illustrated by the paper of Carter and Coulter which appears in this issue of the *ARCHIVES*. Aside from an understanding of the apparatus used, the experimental work described in this paper is relatively simple, yet it teaches some important facts. For those who make use of electrotherapeutic equipment, it is important to know that with increasing frequency a patient tolerates more alternating current provided the size, composition, pressure and placing of the electrodes remain the same. It is even more important to know that there is a tendency for skin resistance to decrease during the application of the direct current, thereby increasing current density and the danger of

tissue damage. It is in this way that fundamental research in physical therapy minimizes empiricism and renders service to clinical practice.

In the teaching curriculum also there is need of more attention to the physiologic action of the physical procedures. Pharmacology has assumed an important place in the curriculum of medical schools. It is the sine qua non of scientific drug therapy. In the same way, there should be presented somewhere in the medical curriculum a certain amount of teaching of the physiologic action and effects of the various procedures which are classed as physical therapy. Such instruction should be given before the student enters on his clinical studies proper. If a separate course is not feasible, this teaching can well be done in connection with physiology or pharmacology. It is only when the medical graduate understands the underlying physiology that he will be able to use physical therapy most scientifically and effectively.

TECHNICIANS' EXAMINATIONS

Examinations for Registered Physical Therapy Technicians will be held on or near June 1st in Boston, Buffalo, Richmond, Va., St. Louis, Mo., New York City and in other cities as the demand arises. Applications should be filed as early as possible. For further information inquire of the American Registry of Physical Therapy Technicians, 30 North Michigan Avenue, Chicago.

MEDICAL NEWS

American Congress of Physical Therapy

Advances in Education

William Bierman, M.D., *Chairman*.
Frances Baker, M.D.
Frank H. Ewerhardt, M.D.
K. G. Hansson, M.D.
Miland E. Knapp, M.D.

Constitution and By-Laws

Norman E. Titus, M.D., *Chairman*.
John S. Coulter, M.D.
Frank H. Ewerhardt, M.D.

Cooperation With Army, Navy, Public Health and Veterans' Administration

John S. Coulter, M.D., *Chairman*.
Charles R. Brooke, M.D.
Norman E. Titus, M.D.

Finance

Norman E. Titus, M.D., *Chairman*.
Roy Fouts, M.D.
Nathan H. Polmer, M.D.

Legislation

Emil J. C. Hildenbrand, M.D., *Chairman*.
Earl C. Elkins, M.D.
Edwin L. Libbert, M.D.

Medical Economics

Madge C. L. McGuinness, M.D., *Chairman*.
David E. Jones, M.D.
John J. McGuire, M.D.

Meeting Place

Walter J. Zeiter, M.D., *Chairman*.
H. Worley Kendell, M.D.
Madge C. L. McGuinness, M.D.
Milton, G. Schmitt, M.D.
Frederick L. Wahrer, M.D.

Membership

William H. Schmidt, M.D., *Chairman*.
John S. Hibben, M.D.
Richard Kovács, M.D.
Kenneth Phillips, M.D.
Walter M. Solomon, M.D.

Nominating

Norman E. Titus, M.D., *Chairman*.
William Bierman, M.D.
Frank H. Krusen, M.D.
Nathan H. Polmer, M.D.
Frederick L. Wahrer, M.D.

Problems Affecting Technicians

Nathan H. Polmer, M.D., *Chairman*.
Frank H. Ewerhardt, M.D.
Miland E. Knapp, M.D.

Public Relations

William H. Schmidt, M.D., *Chairman*.
John D. Currence, M.D.
Disraeli Kobak, M.D.

Scientific Exhibits and Gold Key Awards

Disraeli Kobak, M.D., *Chairman*.
G. J. P. Barger, M.D.
John S. Coulter, M.D.
Frank H. Ewerhardt, M.D.
Norman E. Titus, M.D.

Southern and Southeastern Sectional Meeting Postponed

The annual meeting and instruction seminar of the Southern and the Southeastern Section scheduled to be held at Memphis in May has been postponed. During 1942 our National Government at Washington requests all organizations to cooperate in curtailing as much as possible, group travel which may serve to utilize or tie up transportation equipment. The increased demand on physicians' services will make it difficult for them to leave their communities as frequently as was possible during peacetime. A Section on Physical Medicine is now established within the Southern Medical Association and will meet at Richmond in November. The officers of the Southeastern Section request that full support be given the meeting at Richmond, since the permanency of the Section will depend upon the showing made at this first assembly.

New Course for Physical Therapy Technicians

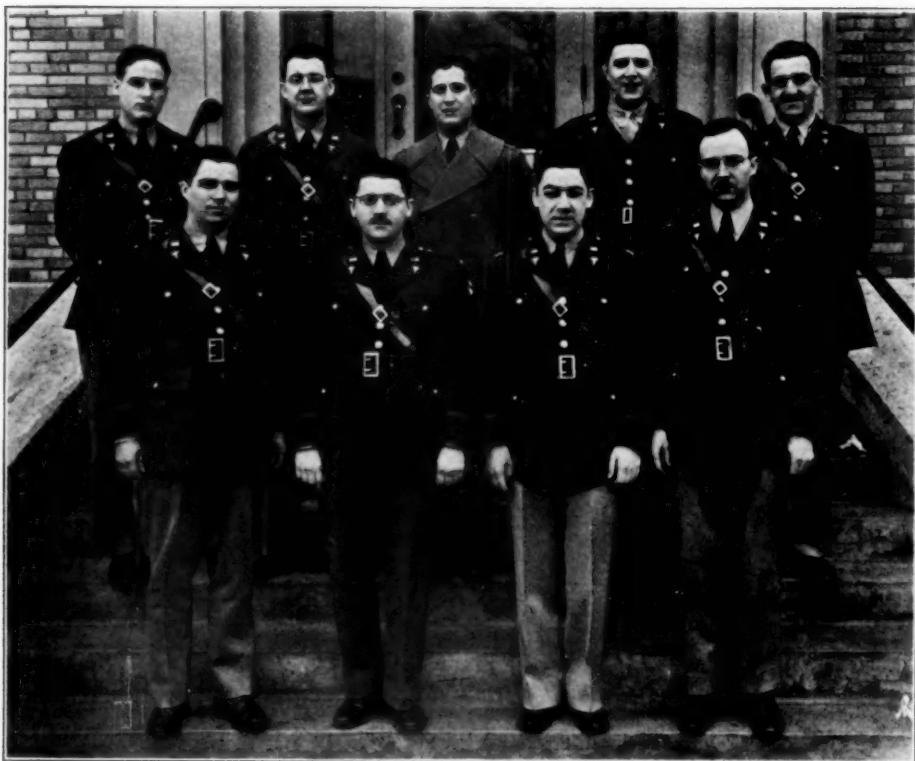
The Cleveland Clinic Foundation, Frank E. Bunts Educational Institute, Cleveland, Ohio, announces the opening of a course for physical therapy technicians, to start July, 1942. The Medical Director of the new course will be Dr. Walter J. Zeiter.

New York Physical Therapy Society

The Nominating Committee of the New York Physical Therapy Society presented the following officers for 1942:

President — Harold Neifeld, M.D.
Vice-President — Charles G. Buckmaster, M.D.
Treasurer — Richard Kovács, M.D.
Secretary — Madge C. L. McGuinness, M.D.
Executive Committee — Drs. Lewis J. Silvers, Chairman, Stella S. Bradford, Karl Harpuder, Sidney Licht, Michael J. O'Connor.

Physical Therapy Physicians for Our Armed Forces



Top row, reading left to right: Lt. D. M. Hayes, Lt. D. W. McCormick, Capt. A. O. Loiselle, Lt. Alfred Cherry, Capt. J. R. Stone. Bottom row, from left to right: Lt. W. M. Tipton, Lt. A. M. Pruce, Capt. J. J. DelVecchio, Lt. N. L. Cardey.

The photograph represents the first group of army medical officers who have been trained to direct army physical therapy departments. Their training consisted of a three-month course at the Mayo Clinic, Section on Physical Therapy, Dr. Frank H. Krusen, Director; Dr. Earl C. Elkins, Assistant Director.

Abstract of Important Communication to the Directors of Schools for Physical Therapy Technicians

Since the declaration of war, the status of male student physical therapy aides and apprentice physical therapy aides as well as senior physical therapy aides has altered. Although we had been advised previously that "The position of Physical Therapy Aide in the Medical Department of the United States Army is available to either men or women;" and although a motion was passed "that the Selective Service System advise Local Boards of the current need for physiotherapy aides and the desirability of permitting students to complete such training before induction," nevertheless, a recent ruling indicates no interference will be made with the Draft Board, either while the male students are undergoing training or after they have been appointed.

The policy is to cooperate with the general defense policy in not interfering with Selective Service.

It is reliably stated that even if the Surgeon General's Office wished to do so, it could not any longer

ask that any of its civilian employees be deferred. Administrative memorandum No. 47 issued by the War Department proper has stated that "the policy of the War Department" is to "encourage its employees to respond to orders to active military duty under the Selective Training and Service Act." Furthermore, this administrative memorandum stated: "The War Department should be an example for other Government departments in making a maximum number of men available to the armed forces."

It becomes apparent, therefore, that the War Department cannot deviate from its avowed policy as set down in administrative memorandum No. 47. Therefore, according to present rulings, any male physical therapy technician, either a student or one employed in the service, will be subject to the draft and the War Department will not ask for his deferment. It may be that as members of the enlisted personnel of the Army, these men can still be assigned for service to departments of physical therapy in army hospitals.

If there are any new developments with regard to the status of these male technicians, we will try

to keep you informed concerning them. It would seem that in the future the approved schools for physical therapy technicians should concentrate on the training of female students who are graduates of courses in physical education or female students who can comply with the minimum requirements of two years of college training, including courses in physics and biology. At the present time, nurses are needed badly in the Army Nurse Corps, and it would probably be wise to keep the number of students who are drawn from the nursing profession to a minimum.

If you place your students in uniform during the time of their training with you, you may now, at their option, save them the expense of buying two sets of uniforms by placing them immediately in the uniform of an apprentice physical therapy aide. Specifications for making these uniforms can be obtained from the Chief Physical Therapy Aide, Walter Reed General Hospital, Washington, D. C. These uniforms are blue in color and you can give the students, if you like, the option of obtaining them or not. There is no objection to their use by physical therapy aides now training as students in civilian institutions. On January 29, 1942, the plan was approved to permit students who are training for service as apprentice physical therapy aides in army hospitals to wear such uniforms at their option while training in civilian institutions.

It has been brought to our attention that there has been delay in the placing of graduate technicians (physical therapy aides) and of apprentice physical therapy aides after they have completed regular or emergency courses in our civilian schools. It has been claimed that these delays have occurred in the office of the Civil Service Commission and that periods of as much as three months have elapsed between the time that applications were submitted and appointments to army hospitals were made.

Some of these delays may be obviated if directors of civilian schools for physical therapy technicians (physical therapy aides or apprentice physical therapy aides) will give careful attention to the instruction of their students in the proper method of making application for positions in governmental service. Graduates of regular courses for physical therapy technicians should obtain from the United States Civil Service Commission, Washington, D. C., or from the nearest Post Office the Civil Service Form No. 24, revised, assembled, headed "Physiotherapy Aide, \$1,800 a Year." They should fill out this form in detail and comply with all of the requirements listed in the form, take the necessary examination, which is an open examination at all times now, and obtain registration at the earliest possible moment. Students who are about to be graduated from regular courses for physical therapy aides should take care of these details well in advance of the date of graduation so that they can take the examination at the earliest possible moment.

Students in the emergency six-month courses for apprentice physical therapy aides should obtain at least three months before graduation from the six-month course from the U. S. Civil Service Commission examination form No. 117, unassembled, headed "Student Physiotherapy Aide, \$420 a Year; Apprentice Physiotherapy Aide, \$1,440 a Year."

They should comply with all of the regulations of this particular form and be certain to specify that they are applying for the position of apprentice physiotherapy aide, not student physiotherapy aide. Student physiotherapy aides are accepted only at the Walter Reed Hospital in Washington, D. C., and get training similar to the training being given in the emergency courses in civilian schools throughout the country.

It is not necessary that students in emergency courses who are planning to be apprentice physical therapy aides should wait until the completion of their six-month course before making application to the Civil Service Commission. At any time while they are students in the emergency courses they can complete the applications, stating when they will be graduated from the six-month training course. Not only should they be certain to specify that they are applying for appointment as apprentice aides and not student aides, but they also should be sure to file all the forms mentioned in form No. 117, unassembled. These include application form 8, application card form 4006-ABCD, and physical fitness form 13 (yellow), to be executed by a doctor of medicine. Preference form 14-Q should be filed only if the applicant desires to claim veteran's preference. All of these forms, then, should be completed well ahead of the time of completion of the emergency course. This will save much delay.

It is not necessary to take any written examination to qualify as an apprentice physiotherapy aide; it is simply necessary to complete one of the approved courses successfully.

Persons who have completed their Civil Service examination forms correctly are assigned promptly to military hospitals. On the day when the final examinations are completed and marked, prompt notification of the Civil Service Commission and a representative of the Surgeon General's Office will permit quick assignment of all students who have passed the examination satisfactorily.

It has been found that when this plan is followed with regard to apprentice physical therapy aides, they are assigned by the Surgeon General's Office within two or three weeks after graduation from the emergency courses for apprentice physical therapy aides, and no extremely long delays have been encountered when the Civil Service forms have been executed properly in advance.

Also, there seems to be some misunderstanding about the amount of science required by applicants for physical therapy courses who qualify under the classification "two years of college work, including courses in physics and biology." Two years of college work means simply sixty semester hours of work in an approved college. The Council on Medical Education and Hospitals merely specifies that there should be included in this two years of college work a course in physics and a course in biology. No specific number of hours has been listed. Apparently some of the schools got the idea that students must have twenty-six hours of science. There is no such specification in the ruling of the Council on Medical Education and Hospitals of the American Medical Association.

Also, there is one other point which seems to be misunderstood by some of the schools. In those

schools which give the emergency six months' courses, the written examination of the American Registry of Physical Therapy Technicians can be given just before the end of the six-month period so that these students can complete the didactic part of their work and take the examination before they get into the various military hospitals as apprentice physical therapy aides; but even though these students are given the examination at the end of the first six-month period, they should not be certified as graduates of the school until they have finally completed their second six months of practical training as apprentice physical therapy aides, in other words, at the end of one full year of training.

It is advisable to make extreme efforts to enroll the very largest possible number of students commensurate with teaching facilities. In a letter addressed to the Council on Medical Education and Hospitals by a representative of the Surgeon General's Office on January 20, 1942, appears the following statement: "With the great expansion of the Army and the paucity of the required number of Physical Therapy Aides, something must be done and must be done immediately." It is imperative that we fill our schools to the limit of their capacity at the very earliest moment. Earnest cooperation will be sincerely appreciated.

Dr. Weiskotten Appointed Secretary of Council on Medical Education and Hospitals

The Board of Trustees of the American Medical Association has appointed Dr. Herman Gates Weiskotten secretary of the Council on Medical Education and Hospitals to succeed the late Dr. William Dick Cutter. Dr. Weiskotten was born in Syracuse, N. Y., in 1884 and graduated from Syracuse University College of Medicine in 1909. Following an internship in the Hospital of the Good Shepherd in Syracuse he was instructor in pathology and bacteriology in his alma mater, 1910-1912, then assistant professor of pathology, 1912-1913, and later associate professor, 1913-1917. Since 1917 he has been professor and head of the department of pathology. From 1922 to 1925 he was acting dean of Syracuse University College of Medicine and since 1925 has been dean and director of the University Hospitals. From 1926 to 1928 he was also commissioner of health of the city of Syracuse. He is a member of the New York State Public Health Council and a member of the American Association of Pathologists and Bacteriologists. A few years ago Dr. Weiskotten collaborated with the late Dr. Cutter in a personal inspection and survey of the medical colleges of the United States and Canada.—J. A. M. A. 118:900 (March 14) 1942.

American College of Surgeons Holds One Day Sessions on Military Medicine

A series of special programs on medicine and surgery in military service and in civilian defense were offered throughout the country to permit participation of medical and hospital professions in

every state and the District of Columbia, under a cooperative plan of the U. S. Army, U. S. Navy and the Office of Civilian Defense with the American College of Surgeons. About thirty of these meetings were held. A similar arrangement is contemplated in Canada. In the United States, meetings were held in five areas. The first group is as follows:

AREA 1: Monday, March 2: Indiana and Kentucky, Brown Hotel, Louisville; Wednesday, March 4: Arkansas and Tennessee, Andrew Jackson Hotel, Nashville; Friday, March 6: Missouri, Jefferson Hotel, St. Louis; Monday, March 9: Illinois, Stevens Hotel, Chicago; Wednesday, March 11: Michigan, Statler Hotel, Detroit; Friday, March 13: Ohio and West Virginia, Deshler-Wallack Hotel, Columbus.

The army was represented at the meetings in Louisville, Nashville and St. Louis by Brig. Gen. Charles C. Hillman, Chief of Professional Service, Division, Office of the Surgeon General, and in Chicago, Detroit and Columbus by Major Roger G. Prentiss, Jr., Medical Corps, Carlisle, Pa. The navy was represented by Capt. Frederick R. Hook, Chief, Surgical Service of the U. S. Navy Hospital, Washington, D. C. The Office of Civilian Defense was represented by Dr. William S. Keller, Glendale, Ohio, at the Louisville and Columbus meetings; by Dr. Judson D. Dowling, Birmingham, Ala., in Nashville, and by Dr. John S. Coulter, Chicago, in St. Louis, Chicago and Detroit. The Procurement and Assignment Service was represented by Major Sam F. Seeley, Washington, Executive Officer.

Consulting Practice in London—Present and Future

The following abstract from a recent letter received by one of our Editors from a surgical friend in London may prove of general interest:

"Consulting medical practice has also suffered greatly in London; this has been not from over-crowding as in your case but from migration of a large proportion of well to do people out into the country and the fact that people no longer wish to come up to London for consultations and as a result the specialists in the country who are not in the army are in some places doing very well indeed.

"Even before the war the standard of surgery especially was getting very high in the provincial towns and it was getting increasingly difficult to earn a living as a consulting surgeon, in the future I think it highly probable that Harley Street will almost go out of existence, all consulting rooms will be attached to hospitals where there will be facilities for private patients and nursing homes will cease to exist. This was already coming in before the war. Staffs of hospitals will receive salaries which will at any rate enable them to live rather than have to scramble for money in a ceaseless competition which ruins a young man's chance of doing really good work.

"One hears a lot about state medicine at present but I doubt if it will come entirely into being but the hospitals will undoubtedly be more state aided and the staffs will be more adequately rewarded for their work than in the past."

Meeting Penna. Academy of Physical Therapy

The Penna. Academy of Physical Therapy held their regular March meeting in the Philadelphia County Medical Society Building, March 19, 1942. Dr. *Bernard I. Comroe*, Instructor of Medicine, University of Pennsylvania spoke on "The Physical Therapy Treatment of Arthritis."

National Headquarters, Selective Service System, Washington, D. C.

Tests of a physical rehabilitation program, intended to make many registrants who were rejected because of minor physical defects fit for active military service, have been authorized in Maryland and Virginia. National Headquarters, Selective Service System, has announced.

Authorization of the rehabilitation programs in the two States marks the beginning of a long-planned nation-wide physical rehabilitation campaign. When the results of these pilot tests are evaluated, a date for the inauguration of the National program will be set.

Only those registrants whose disabilities are certified by the Army as being remediable will be eligible to undergo treatment.

As one of the first steps in the Maryland and Virginia test programs, the Director of Selective Service of each State will submit to National Selective Service Headquarters lists of physicians and dentists qualified to correct physical defects of registrants. Physicians and dentists designated to render these authorized professional services will be paid by the Federal Government.

National Headquarters emphasized that any physician or dentist can apply to be designated to assist in the rehabilitation program. Physicians and dentists not already designated by registrants as their choice for dental or medical treatment, and other physicians and dentists who wish to take part in the program, may obtain the necessary application forms from their local boards.

Twenty-first Annual Convention, the American Physiotherapy Association

The American Physiotherapy Association will hold its Twenty-first Annual Convention at Lake Geneva, Wisconsin, from June 28th to July 3rd, 1942.

Officers and members of the American Congress of Physical Therapy are cordially invited to attend.

Rock Sleyster

President of the American Association, 1939-1940, died, March 7, at his home in Wauwatosa, Wis., aged 62, of heart disease. Dr. Sleyster was born in Waupun, Wis., June 14, 1879. After graduation from the College of Physicians and Surgeons of Chicago, School of Medicine of the University of Illinois, in 1902 he entered the practice of medicine.

Dr. Sleyster was one time Vice Speaker of the House of Delegates. He became a Trustee of the American Medical Association in 1926 and served continuously until 1937, acting as Chairman of the Board from 1935 to 1937. He became medical director of the Milwaukee Sanitarium, Wauwatosa.

Dr. Sleyster was devoted to the service of his profession and to its members. He gave freely of his time and worked many extra hours both day and night for the advancement of medical organization. He was gentle, modest, thoughtful and altogether a most cultured and genial gentleman.—J. A. M. A. 118:915 (March 14) 1942.

Dr. Edgar A. Ill 1882-1942

It is with regret that we announce the passing of Dr. Edgar A. Ill of Newark, N. J., a member of the Congress since 1924. Dr. Ill was graduated from the Columbia University College of Physicians and Surgeons in 1910 and licensed to practice medicine the same year. He was a Fellow of the American Medical Association, a member of the American Urological Association, The American College of Surgeons and the American Radium Association. The Congress extends its sympathy to the members of his family.



BOOK REVIEWS

SURGERY OF THE AMBULATORY PATIENT. By Kraemer Ferguson, A.B., M.D., F.A.C.S., Lieut.-Commander, Medical Corps, United States Naval Reserve. With a Section on FRACTURES by Louis Kaplan, A.B., M.D., F.A.C.S., Associate in Surgery, University of Pennsylvania. Cloth. Price \$10.00. Pp. 923 with 645 illustrations. Philadelphia, New York, Chicago and London: J. B. Lippincott Company, 1942.

With the advent of "The Horse and Buggy Doctor" and other popular books on medical subjects, more interest has been given to the care of patients outside of hospitals than before. There are excellent textbooks on general medicine and numerous books on general surgery. However, most of these books seem to have been written by hospital staff members about the treatment of patients in hospitals. The treatment of ambulatory patients has been neglected in medical schools and hospitals, and most of the time of students and interns has been taken up with major medical or surgical cases. They are ill prepared for minor surgical cases when they begin practice. Also, the recent interest of the public in first aid has brought out the unpreparedness of the physician in general to do more than just what the first aid textbook suggests. Every chapter in the Red Cross manual warns the first aider to call a physician as soon as possible.

Dr. Ferguson's book is therefore timely and meets a long felt need. It is comprehensive. (Incidentally, the printing is well spaced and clear, on paper of good quality, which makes for easy reading.) It is divided into three parts: The first describes the cause, course and care of typical lesions; the second includes regional surgery and discusses the detailed treatment of surgical lesions of the specific parts; the third deals with fractures and dislocations in ambulatory patients. (The last part is written by Dr. Louis Kaplan.) Part I has twelve chapters and discusses equipment, anesthesia, operative technic and postoperative care as applied to the treatment of the more common surgical emergencies. It is up to date in every respect, as evidenced by the inclusion of chemotherapy. Part II, on regional surgery, discusses in a masterly way both common and rare pathologic changes. It includes excellent discussions on such controversial subjects as low back pain; it presents ingenious applications of hairpins in the treatment of finger lesions, and it describes valuable aids in the treatment of epistaxis. Part III, on fractures and dislocations, is really a book in itself. The chapters are comprehensive, rational and well illustrated.

Every chapter is followed by a bibliography, which makes the book much more valuable. This book is a godsend to every physician in general practice and to all surgeons treating ambulatory patients, and it should be on the shelves of all outpatient dispensaries. It should be the bible of interns and

medical students and should take its place in the company of Osler and Cecil on medicine and DaCosta and Lewis on general surgery.

NEURAL MECHANISMS IN POLIOMYELITIS. By Howard A. Howe, M.D., Associate in Anatomy, The Johns Hopkins University, Baltimore, and David Bodian, Ph.D., M.D., Assistant Professor of Anatomy, Western Reserve University, Cleveland. Cloth. Price, \$3.50. Pp. 234. New York: The Commonwealth Fund, 1942.

This is a monograph presenting the results of a series of experimental studies of poliomyelitis in animals. The following subjects are presented: the neurotropism of poliomyelitis virus; mechanism and rate of virus spread in the peripheral nerve and the genesis of cerebral lesions; the role of neurons in the dissemination of virus in the central nervous system; the behavior of virus in peripheral nerves and in nonnervous tissues; the portal of entry problem in the experimental animal and in man; the pathology of early arrested and non-paralytic poliomyelitis; virus-refractory states in nerve cells and the problem of immunity in poliomyelitis presented by second attacks. The authors have made a contribution to the knowledge of the mechanisms of the disease which paves the way to its better understanding. A comprehensive consideration of poliomyelitis must deal with three obvious general aspects of the disease: (1) the means by which the virus is transmitted from one person to another; (2) the portals through which the virus enters the body and the routes of dissemination within it; (3) the interactions between the virus and the tissues of the host which determine the spread of pathologic change and which may either favor the spread of infection or limit it. For practical reasons these fall into different spheres of interest and require for their solution the technical specializations of several biological and medical disciplines.

To understand the mode of action of virus one must know more of the nature of its reaction with the tissues of the central nervous system, whether it attacks only the nerve cells themselves or also reacts with the supporting cells of nervous origin, the neuroglia. The fact that there are in the nervous system groups of nerve cells of sharply differing susceptibilities presents a striking example of the elaborately complex conditions which appear to be necessary for virus growth and propagation. This brings up difficult questions concerning the biochemical relations between the virus and the susceptible host cell. These and many other questions have not yet been answered. But the demonstrations of various phases in the biologic interaction between a highly selective virus and its host cells should merit attention from all interested in poliomyelitis.

THE DOCTORS MAYO. By *Helen B. Clapesattle*. Cloth. Pp. 822, with 157 illustrations. Price, \$3.75. Minneapolis: The University of Minnesota Press, 1941.

In the biography of the three Doctors Mayo, Miss Clapesattle necessarily has provided a chronicle covering a century of tremendous advance in medicine and surgery. The Mayos contributed much to this program; and thus the story of their lives is the story of their times. Beginning with the life of William Worrall Mayo, the author traces the early training and education of Dr. Will and Dr. Charlie. She tells how these three men became renowned and how their unique type of group practice evolved with the spreading of their fame. This subsequently led to the establishment of the Mayo Clinic and later to the organization of the Mayo Foundation for Medical Education and Research. The development and workings of these institutions are described accurately. William Worrall Mayo passed on to his sons the precepts and principles which formed the foundation of their work. Dr. Will frequently expressed the belief that their success was achieved because they were "born at the right time and to the right parents." After reading about their lives, however, one can question whether the time was right or whether they themselves caused it to be so. It was their democratic viewpoint, their wide scope of vision and their humanitarian ideals which made them truly great men. Everyone who knew them, all whose lives were enriched by contact with them, all who have profited by their teachings and experiences, in fact, everyone will want to read and enjoy this remarkable book which Miss Clapesattle has written with painstaking historic accuracy and admirable restraint.

SHOCK TREATMENT IN PSYCHIATRY: A MANUAL. By *Lucie Jessner*, M.D., Ph.D., Resident Psychiatrist, Baldpate, Georgetown, Mass.; Graduate Assistant in Psychiatry, Massachusetts General Hospital; Assistant in Psychiatry, Beth Israel Hospital, Boston, and *V. Gerard Ryan*, M.D., Associate Psychiatrist, Elmcrest Manor, Portland, Conn.; Assistant in Psychiatry, Harvard Medical School. Introduction by *Harry C. Solomon*, M.D., Clinical Professor of Psychiatry, Harvard Medical School; Chief of Therapeutic Research, Boston Psychopathic Hospital. Cloth. Pp. 149. Price, \$3.50. New York: Grune & Stratton, Inc., 1941.

This monograph gives a brief, practical review of "shock therapy." Dr. Solomon in his introduction well stated, "Shock therapy has thrust its none too-pretty form into the field of psychiatry. Whatever the method of producing "shock" the process itself is distasteful. The patient is thrown into a state that is contrary to normal physiological functioning. His whole metabolism is gravely upset. And moreover, the whole process is empirical, with no acceptable explanation of reason for the beneficial results that may occur. Nor is it free from danger to the recipient. Nonetheless, it is here, and is likely to remain with us until better methods are found.

Therefore, it is well to have a text to study, which reviews the literature and discusses details of procedure, indications for its application, results to be anticipated, dangers to guard against." It is divided into three parts considering insulin, metrazol and electric convulsive therapy. Convulsive shock therapy opens a new line in psychiatry. This book should be of value not only to the psychiatrist who must carry out the procedures described or advise as to their value to the individual patient, but to the medical scientist who may be intrigued by the problems raised by "shock therapy."

A HANDBOOK OF OCULAR THERAPEUTICS. By *Sanford R. Gifford*, M.A., M.D., F.A.C.S., Professor of Ophthalmology, Northwestern University Medical School, Attending Ophthalmologist, Passavant Hospital, Wesley Memorial Hospital and Cook County Hospital, Chicago. Third Edition, Cloth. Pp. 410 with 69 engravings. Price, \$4.00. Philadelphia: Lea & Febiger, 1942.

Although the author has greatly expanded this edition, it is still a concise handbook of ocular therapeutics. The section on vitamins has been completely rewritten, for, as the author stated, the isolation of a number of vitamins in crystalline form, the recognition of various clinical pictures due to deficiency of certain vitamins and the standardization of dosage in treating resulting conditions constitutes perhaps the most important advance in medicine during the past five years. The sulfonamide group of drugs which was not mentioned in the previous edition have become so valuable that a full discussion is presented of their rationale, dosage and specific indications. The subject of the parasympathomimetic and sympathomimetic drugs is fully discussed from the theoretic and practical aspects. Consideration is also given to the newer drugs such as mecholyl, prostigmine and furfural trimethyl ammonium iodide. The book has a definite interest to every physician using physical therapy. In the chapter devoted to this subject there is presented the important advances in the treatment of eye conditions by phototherapy, heat and cold, medical diathermy, hyperpyrexia by physical means, surgical diathermy, the thermophore, massage, roentgen ray and radium. An up-to-date bibliography follows each chapter and the illustrations are especially fine. The volume can be highly recommended.

ADMINISTRATIVE MEDICINE. By *Haven Emerson*, A.M., M.D., Editor. Loose-Leaf Fabricoid. Price \$7.50. Pp. 839 with illustrations. New York: Thomas Nelson & Sons, 1941.

Dr. Haven Emerson has had a long experience in administrative medicine and public health. He has collected excellent contributions from fifty-six authorities in their respective branches of the subject. The loose leaf volume is divided into three parts. In Part I there is presented the development of the organized care of the sick in its chronologic sequence from its original, and still its most important, function of general hospital care of bed patients, through to the elaborate and socially precious symbol of public interest in securing the best services of

the medical sciences for all who need them, but the special purpose institutions for the communicable diseases, tuberculosis, mental, and other chronic diseases are described with appropriate detail, to meet the need of the practicing physician, the board member, the philanthropist, and the officer of civil government. In Part II, the arrangement and approach are more according to the patterns of governmental and social structure than along the lines of historic development. First, the official and then the voluntary or nonofficial health services are dealt with, then the international, national, state or provincial, and local, city, county, or district. In the four

chapters of Part III there are illustrations of specific and accepted instances of current practice for certain groups and something of the theory and proposals of such a socialized use of the medical and associated professions. This is without too much discussion of all the implications of such ideas on the prevalent social, economic, and professional relations of medical personnel and institutions to the existing or a possibly more desirable order of human affairs. The book can be recommended to all physicians interested in administrative medicine.

Technic for Reduction and Ambulatory Treatment of Sacroiliac Displacement — Travell and Travell

(Continued from page 234)

The chief difficulty in making the diagnosis of sacroiliac displacement is the general lack of roentgenographic evidence. However, some roentgenologists feel that such displacements can be demonstrated by special technics. Roentgenographic examination of this joint is, of course, notably unreliable. I may remind you of Horowitz and Smith's study which showed that bony ankylosis of the sacroiliac joint could not be correctly diagnosed in the cadaver by roentgen rays taken at various angles. Furthermore, even the normal motion in the joint is not visualized by the usual films.

As Dr. Ullrich said, the differential diagnosis is exceedingly important. I wish to emphasize that in this condition we always find localized tenderness over the posterior margin of the sacroiliac joint. The type of deformity, which depends on spasm of the muscles, is not especially significant.

Another point which may be taken not as proof but as a kind of evidence of displacement is the eliciting of an audible snap or click by manipulation. This occurs in most patients, usually at the time of the final thrust when motion in the joint is presumably greatest. By means of the stethoscope it may be possible to localize the sound sharply in the sacroiliac joint and we believe that it is indicative of motion in the joint.

I cannot agree with Dr. Ober that this syndrome is nearly always due to muscular spasm. We have seen cases with back pain due to muscular spasm alone,

and this simple manipulation does not help them. Furthermore, muscular spasm is the most annoying complication of displacement, and when extensive, manipulation may fail to obtain immediate relief.

Once the diagnosis is established, a great deal of suffering may be spared the patient by early application of manipulative treatment. I think the risk attending the manipulative procedure we have described is negligible. One reason is that a general anesthetic is not used. It is difficult to manipulate with too great force when the patient can protest. Another reason is that a single procedure is employed which apparently never moves the joint in the wrong direction. It is possible to displace this joint by certain types of manipulation. I, myself, have had a sacroiliac displacement made worse by osteopathic manipulation. Also many patients in our series had had osteopathic manipulations; some were made better, others worse. I feel that some osteopaths do replace these displacements, but it is likely that others do not use a satisfactory technic.

Dr. Hansson said that about the same per cent of cases of low back pain were cured by whatever procedure one uses. By that I think he has in mind a long complicated series of procedures, including surgical fusion of the joint, which keeps the patient in bed for weeks. The advantage of our technic is its simplicity, and my plea is that it should be given a trial in this condition early rather than late.



PHYSICAL THERAPY ABSTRACTS

Diseases of the Respiratory System. W. D. W. Brooks.

Practitioner 115:5:683 (Nov.) 1941.

It has become recognized that the healthy person in many instances breathes inefficiently. When he becomes the subject of a respiratory disorder, not only has this initial disadvantage enhanced significance, but its correction, and that of the consequences of the lesion from which he suffers, can frequently be attained by suitable exercises, to his great benefit. As a consequence, in the last decade the part played by physical therapy in the treatment of respiratory disorders has undergone a dramatic change.

In asthma, breathing exercises, based on those originally devised by MacMahon, have been shown to reduce the frequency and severity of the attacks, and constitute a valuable adjuvant form of treatment. They are of less but real value in cases of emphysema and chronic bronchitis.

Analogous exercises, particularly directed to improving inspiration, are of vital importance in resuscitation after such lesions as empyema, haemothorax, pleurisy with effusion, and after lobectomy, since re-expansion of the underlying lung can thereby be facilitated.

In broncho-pneumonia, and after drainage for lung abscess, breathing exercises may be used at a relatively early stage and may assist in limiting spread of the disease. In later stages of these illnesses, during convalescence from lobar pneumonia, and with unresolved pneumonia, they may well accelerate recovery and prevent the development of bronchiectasis.

Finally, the extended use of massage, passive exercises, and later physical training, constitute an important therapeutic factor in the recovery stages from most severe respiratory disorders.

The Importance of Air-Borne Pathogenic Bacteria in the Operating Room. A Method of Control by Sterilization of the Air With Ultraviolet Radiation. Deryl Hart.

J. A. M. A. 117:1610 (Nov. 8) 1941.

During the first five and one-half years at Duke Hospital, as a result of extensive studies carried out in an attempt to determine the cause of "unexplained infections" in clean wounds, Hart was forced to the conclusion that pathogenic bacteria floating in the air and sedimenting on the wound and sterile field were the cause of most of the unexplained infections in our operating rooms. Hart was unable to control this source of infection despite many changes in technic until ultraviolet radiation (predominantly 2,537 angstroms) was utilized to kill the bacteria (and fungi) in the air or after they sedimented on the sterile field.

It is felt that the air contaminated by the organisms given off from the noses and throats of the occupants of the operating room today is the greatest breach in so-called aseptic technic and is the cause of the majority of wound infections in well run operating rooms with a relatively good "atraumatic technic."

Ultraviolet radiation (2,537 angstroms) offers the simplest and most effective means of eliminating this source of danger and in proper intensities can be used without evident danger to the patient or to the well protected personnel.

By this means, over a period of five years and eight months, Hart has secured improved wound healing, has eliminated deaths from unexplained wound infections in clean wounds, has reduced unexplained infections from one-twentieth to one one-hundredth of the previous level and has secured a most gratifying reduction in both the elevation of temperature and the duration of this elevated temperature in patients following operation.

Treatment of Chronic Arthritis. Russell L. Cecil.

J. Missouri M. A. 38:368 (Nov.) 1941.

Osteo-arthritis is one of the commonest types of arthritis the physician has to face, and as the population grows older there will be more and more of it. It is well to remember that osteo-arthritis is not really a disease, because it rarely appears except in elderly persons. In old people, the cartilage becomes thin, the bones rub against each other and spurs form around the joint margins. The first thing the author stresses in the treatment of osteo-arthritis is rest; not necessarily rest in bed, but plenty of rest. Physical therapy has one of its most important places in the treatment of osteo-arthritis, regardless of location. In the hands, the paraffin pack is used three or four times a week and short or long wave diathermy is used on the knees and back.

Rheumatoid arthritis is a common form of joint disease and difficult to treat. One can treat these patients in the home, in the hospital, in a sanatorium or in the office or outpatient clinic. The patients to be put in the hospital are those who have a good deal of pain and are really sick.

As soon as possible physical therapy is used and the author tries to get the patient into the warm pool so he will get exercise and the feeling of well-being that the pool produces. Two or three treatments a week are sufficient in most cases. If the patient cannot take the pool treatment, a certain amount of exercise is given him in bed, lying on the back and making movements, to prevent muscular weakness, preserve the use of the joints and prevent ankylosis.

Cecil uses vitamins of course, but has never seen any miracles from the use of vitamins in rheumatoid arthritis.

In the home, the treatment of rheumatoid arthritis is much the same, although not so satisfactory. The patients should have long rest periods every day and plenty of heat.

The usual method of treating arthritis is in the office or clinic. The reason is obvious; most arthritic patients are poor.

When patients go to the office for treatment they should have a certain amount of physical therapy at home, and they have to have instruction on this matter.

Gold now can be used with a fair degree of safety although it must be admitted that it is dangerous.

Interference With Radio Communications.

Editorial J. A. M. A. 117:1787 (Nov. 22) 1941.

Electromedical equipment may interfere with radio communication. Physicians do not, of course, desire to interfere with radio communications, but owing to the characteristics of the equipment a portion of the energy may escape the apparatus and appear in space as an unwanted radio signal, thus interfering with communications. Although great progress has been made in the construction of x-ray apparatus, the old type of x-ray equipment is still a source of interference. Efforts have been made to solve this problem in the field of diathermy. Cooperation now prevails among the several interested groups, including the Federal Communications Commission, the manufacturers of electromedical equipment, the radio communications interests and the Council on Physical Therapy, which represents the medical profession.

The Federal Communications Commission is trying to solve this problem not only without having recourse to licensing, as in England, but without creating any condition likely to place a burden on a practicing physician or increase the cost of diathermy treatments to the public. Since the radio channels affected by diathermy operation are invaluable to the armed forces for other national defense uses, and for many important communications services needed to fulfill the requirements of the general public, the medical profession will of course assist in all ways possible to solve this problem.

Some Effects of Sulfanilamide on Man at Rest and During Exercise. F. J. W. Roughton; D. B. Dill; R. C. Darling; Ashton Graybiel; C. A. Knehr, and J. H. Talbott.

Am. J. Physiol. 135:77 (Dec. 1) 1941.

At rest and in moderate exercise (5-6 times the resting metabolism) the rate of carbon dioxide elimination is unchanged in human subjects by administration of sulfanilamide to a blood concentration of 3 to 4 milligram per cent.

In exhausting exercise there is definitely some handicap in carbon dioxide removal, resulting in the damming back of carbon dioxide. This adds

to the acidosis of lactate formation and results in prolonged dyspnea during recovery.

The degree of psychologic and general physical handicap observed in subjects taking 2 to 3 grams of sulfanilamide daily was severe enough to make its prophylactic and therapeutic use unsuitable in patients expected to continue exacting or strenuous work, especially if this requires skill. According to calculations for moderate exercise normal carbon dioxide exchange in the lungs requires sufficient carbonic anhydrase in the red cells to speed the reaction $H_2CO_3 \rightleftharpoons H_2O + CO_2$ 75-fold. Independent deductions from previous studies of the inhibitory action of sulfanilamide on dilute enzyme solutions and from present measurements of the enzyme inhibition in the intact red cell suggest that the residual enzyme activity in the presence of 3 to 4 milligrams per cent sulfanilamide is at or near the above threshold.

There is however some evidence from the measurement of carbon dioxide tensions in the alveoli and in the venous and arterial blood of subjects performing moderate exercise after sulfanilamide that the enzyme activity of the carbonic anhydrase is not quite adequate and that the carbamino mechanism may be performing a greater share in the transport of carbon dioxide.

Diathermy Burns. Queries and Minor Notes.

J. A. M. A. 117:1660 (Nov. 8) 1941.

To the Editor: — Last June I treated a woman with diathermy by placing a pad on the back and one on the lower abdomen. She complained of a great deal of pain in the lower abdominal wall after the treatment and claimed that she sustained a burn. At no time was there even a blister or any scaling of the skin. There was, however, a redness of the skin after the treatment and later on area that had a slightly blanched appearance, and this was somewhat indurated. It was felt that she magnified any symptoms she might have. Can you give me an explanation as to what took place in the abdominal wall? Is it possible to get a burn of the deeper structures of the abdominal wall under such conditions without having a blister or slough? M.D., New York.

Answer. — In the administration of medical diathermy it is not believed possible to create a burn in the deep tissues without a burn of the skin. After the described treatment there was redness of the skin and an area with a blanched appearance and induration. This might have been the preliminary evidence of a diathermy burn. If it was, in three to seven days there would be a necrotic area with a slowly separating slough.

More than four hundred experiments have been made in testing deep tissue temperatures on animals and dogs. In animals burns have been produced to measure the tissue injuries and the deep tissue temperatures. It has been concluded that when a limb is exposed to short wave diathermy the results indicate that the temperature of its tissues decreases from the skin, which is nearest the source of energy, toward the marrow of the bone. This thermal gradient from the surface to the interior of the limb is convincingly demonstrated by the fact that

when the dosage was excessive the histologic damage of the tissues manifested a similar gradient of injury from the skin to the bone. This confirms previous observations on human subjects in which the temperature at different depths in the tissues from the skin to the periosteum has been determined after exposure of the thigh to short wave diathermy.

An Evaluation of Physical Therapy In the Early Treatment of Anterior Poliomyelitis. H. R. McCarroll, and C. H. Crego.

J. Bone & Joint Surg. 23:851 (Oct.) 1941.

These authors stated that no particular form of therapy produced results which were outstanding. In fact, the highest percentage of satisfactory brace-free extremities occurred in that group of patients who received no treatment during the early stages and who began to walk without support as soon as they could get out of bed.

The authors do not wish to imply from this that all orthopedic measures should be discarded in the treatment of the acute stages of this disease. Careful immobilization should be used for three reasons: (1) for the comfort of the patient during the acute stage, (2) to prevent the early development of deformities in an extremity as the result of muscle imbalance and (3) to prevent a stretch paralysis in a partially paralyzed muscle. That this can and does occur at times is evidenced by the fact that after the correction of deformities, return of power is occasionally noted in muscles which have been stretched over a long period. The type of treatment used in the authors' experience is of minor importance in restoring power to the paralyzed muscles, but may be used so long as that plan is carried out within reason and is not actually harmful to the involved muscles.

The results in this series of 160 cases of recent anterior poliomyelitis extending over a four-year period seem to indicate that the type of early treatment has little or no effect on the course of the disease and alters little, if any, the degree of residual paralysis which is seen.

Clinical evidence shows that the amount of residual involvement is primarily dependent on the degree of initial paralysis and the amount of actual destruction which has taken place in the anterior horn cells. There is no way of accurately determining this during the acute illness, but it is at this time that the die for the final picture is cast, and orthopedic measures probably alter little, if any, the course of the disease.

Some Medical, Social and Economic Problems of the Physically Handicapped. Alfred Rives Shands.

Am. J. M. Sc. 202:625 (Nov.) 1941.

Approximately 80 per cent of the crippled children present physical handicaps carried through into adult life, so that almost any discussion of the child will also be applicable to the adult.

It is apropos to quote from the "Crippled Child's Bill of Rights": "Every crippled child has

the right to the best body which modern science can help it secure; the best mind which modern education can give; the best position in life which his physical condition perfected as best it may be will permit; . . ."

Infantile paralysis, as a cause for crippling in childhood, has for years held first place. The two crippling conditions with which little progress has been made in either the prevention or the treatment of, are spastic paralysis and progressive muscular dystrophy. Research is certainly needed to find out more about their causes. These are only a few of the more common conditions causing crippling in childhood.

How can the best mind be obtained and what problems are presented? In nearly all large cities, there is now special provision made for special classes for the teaching of the crippled child. However, this does not in any way adequately meet the situation. There are about 100,000 crippled children in need of special education, and this is provided for only 25 per cent of this number. The two principal reasons for this unfortunate situation is: (1) that the cost is from 3 to 5 times as great to educate a crippled child as a normal one; and (2) that a large part of these crippled ones live in the rural areas where both the transportation to special classes in the schools, if there were such, and the cost of same would be difficult to arrange.

How is the best position in life to be obtained? This is dependent upon the handicapped one's social and economic adjustment.

In discussing the problem of the crippled one, a word should be said about sympathy. This should never be given. It is demoralizing to the person, and so often leads to unnecessary dependency. Crippled ones should associate with the normal in so far as it is possible, and their handicaps completely overlooked.

Before a physically handicapped adult is started on his path to independence and self-sufficiency, there must always be an accurate appreciation and evaluation of his medical, social, and economic status. Perhaps this can best be understood by giving an example of a typical vocational rehabilitation problem. A carpenter falls from a high scaffold and suffers a broken back and two broken heels. He is in the hospital for months, but finally comes out on crutches, and with a back brace. He has always been a carpenter, knows no other occupation, but it is very evident he will never be able to go back to carpentry. First, his physical condition shows weakness and deformity in his back and painful heels. He has been interested in mechanical things, and working with his hands all his life. He is of good intelligence, has an optimistic temperament, has always been conscientious and industrious, and does not want to remain idle in mind or body. Given a vocational training in something he can do while sitting, he will be able to earn his own living in six months' time. There is a demand for good watchmakers. Twelve months later he is not only earning his own living, but is able again to be the sole support of his family.

Those Fracture Cases. Joseph C. Doane.

Mod. Hosp. 57:71 (Aug.) 1941.

This is the second of two articles dealing with the methods by which the reception, diagnosis and treatment of fracture cases can be best performed in the hospital. Such rules should be drawn up by the surgeon in charge of the fracture service or by the neurosurgeon to whom fractures of the skull usually are assigned and also they should be included in the house physician's procedure book.

The nurse must play a prominent part in the carrying out of these instructions. The preparation of shock beds, which, incidentally, should always be in readiness for the reception of such cases, and the intelligent supervision of electric bed warmers, intravenous and transfusion equipment and other modern types of apparatus employed in the treatment of shock are likewise her responsibilities.

In accordance with the regulations of the American College of Surgeons some type of organized fracture service should be made a part of the hospital staff setup. In many institutions this is not the practice and fractures are assigned in rotation to the various surgical services as they are received.

In some hospitals patients with fractures are assigned to the orthopedic department. The wisdom of this practice will depend on the personnel available and upon the staff organization in use. The physical therapy and occupational therapy departments are highly important to the after-treatment of many types of fractures, particularly those of the long bones.

The Conservative Treatment of Serratus Palsy. Josef Wolf.

J. Bone & Joint Surg. 23:959 (Oct.) 1942.

As with other types of muscle palsy, the isolated paralysis of the serratus anterior can be divided into two stages: the acute paralysis from which recovery is possible, and the late stage in which the paralysis is permanent. The same kind of orthopedic appliance cannot be used for both stages.

For the former, the purpose is to splint the muscle in a position of complete relaxation, which eliminates the action of its opponents and, thereby, favors recovery.

The brace which is described fulfills all three requirements. It consists of a metal pad over the protruding scapula, which is molded deep enough to receive the triangular shoulder blade and to hold it with the inner border parallel to the spine, and a second metal pad over the unaffected scapula. Both metal pads are connected by three metal springs.

Osteochondritis Dissecans of Ankle Joint. The Use of Tomography as a Diagnostic Aid. Merrill C. Mensor, and George F. Melody.

J. Bone & Joint Surg. 23:903 (Oct.) 1941.

The term "osteochondritis dissecans" was coined in 1905 by König; however, Alexander

Munro as early as 1738 recognized the condition. This diagnosis is used to denote a disease of obscure origin, characterized by the demarcation and detachment of one or more fragments from the articular cartilage and underlying bone of some joint surface. Pathologically, osteochondritis dissecans is an aseptic necrosis of bone, the inception of which is frequently associated with trauma.

The authors conclude that (1) although but twenty established cases of osteochondritis dissecans of the ankle have been reported, the condition will probably be more frequently detected if tomography is carried out in suspected cases, despite negative findings by conventional roentgenography; (2) in the case reported, the causal relation between the trauma sustained and the development of osteochondritis dissecans seems inescapable. This conforms to the general opinion relative to trauma as an etiologic factor in the production of this entity; (3) chronic pain or discomfort in the ankle following a sprain, dislocation, or fracture which persists despite ordinary conservative treatment, should suggest the possibility of osteochondritis dissecans tali; (4) a history of recurrent instability of the ankle should arouse suspicion relative to the possibility of a loose fragment or "joint mouse"; (5) the treatment of choice is arthrotomy, with removal of the loose fragment or fragments, but without immobilization. This should be followed by rehabilitation therapy in the form of diathermy, massage, and graded exercises, which are important adjuncts in the accomplishment of prompt postoperative recovery of normal function and complete rehabilitation; and (6) prognosis is excellent in patients receiving early diagnosis and appropriate treatment. Such treatment is also a prophylaxis against the development of chronic hypertrophic synovitis and traumatic arthritis.

Twenty Years' Observation of 1,438 Children With Rheumatic Heart Disease. Analytic Study Following Convalescent Care From 1921 to 1941. Alexander T. Martin.

J. A. M. A. 117:1663 (Nov. 15) 1941.

The rheumatic child is best protected by insulating him, as far as possible, from contact with infections of the upper respiratory tract, especially those caused by the hemolytic streptococcus. This we have attempted to do in the three convalescent homes, and isolation technic has been practiced on any child coming down with a cold or sore throat. Herein lies the great value of sanatorial and convalescent care.

An important part of the program in these homes is the educational one. We were fortunate in having outstanding teachers, and many children because of more individualized teaching were able to advance a grade on their return to their school in the city. Occupational therapy was made a vital part of the program. Wood carving, leather work, pottery, metal work, weaving and rug making were some of the many skills that the boys and girls were taught, and many perfected one or more of these to a high degree of

proficiency. Numbers have turned their skill into a wage-earning occupation and have adjusted their physical capacity to their handicap. Music in the form of group singing and choral groups under a trained teacher was a part of the weekly program. This did much to relieve the monotony of a daily routine and served as a much needed emotional outlet. By the same token, dramatics were found to be an important medium to integrate the different personalities of the many nationalities.

Herpes Simplex Following Artificial Fever Therapy. Smallpox Vaccination as a Factor in its Prevention. Frances M. Keddie; R. B. Rees, Jr., and Norman N. Epstein.

J. A. M. A. 117:1327 (Oct. 18) 1941.

These authors conclude that (1) herpes simplex following artificial fever therapy occurred in 227 of 321 patients, or 70.7 per cent; (2) an analysis shows that in 80 per cent of the 227 patients herpes developed after the first treatment, in 13.7 per cent after the second, and in 2.6 per cent after the third. The occurrence of herpes was negligible or absent thereafter; (3) in 29.1 per cent of the patients with herpes the condition recurred during the same series of treatment. Recurrences were noted in 22.1 per cent of those who had been vaccinated and 32 per cent of those who had not been vaccinated; (4) in the 39 patients who received more than one course of artificial fever therapy, herpes was twice as common during the first series as during subsequent series; (5) sex and age were not important factors in the production of herpes; (6) the incidence of herpes was definitely higher in the patients with syphilis of the central nervous system than in those with gonococcal infection; (7) initial high temperatures, i. e. from 40 to 41 C. (104 to 105.8 F.) were more often followed by herpes than were lower temperatures, i. e. from 39 to 40 C. (102.2 to 104 F.); (8) patients with a known tendency toward herpes prior to the artificial fever therapy were more likely to be affected following fever therapy than those without such a tendency; and (9) a single smallpox vaccination did not lessen the incidence of herpes in 100 patients vaccinated prior to artificial fever therapy, irrespective of their reaction to the vaccinia inoculation.

Forty Cases Treated at the Allendale Curative Workshop. Elizabeth Casson.

Lancet 2:516 (Nov. 1) 1941.

Rehabilitation needs serious attention at present. An account of the first year of work at the Allendale Curative Workshop, opened at Clifton, Bristol, in 1939, is therefore of interest.

Weaving and light crafts were carried on in a room which measured about 19 ft. by 17 ft. and allowed space for 10 patients. Slightly heavier work, such as block printing and basket-making, was undertaken in a room (20 ft. by 15 ft.) which provided space for 9 patients. More strenuous work, such as joinery and metal work, was car-

ried on in a long room (42 ft. by 15 ft.) where benches, a lathe, and bicycle and treadle saws were provided; some embossing presses which had been given to us were also in this room. The old dining-room (30 ft. by 20 ft.) was provided with a billiard table, and the conservatory gave room for darts.

The first 40 cases show what useful work can be accomplished. They came chiefly from fracture clinics at the hospitals, and were chosen by their surgeons because of some complication calling for special attention-joints fixed by adhesions, or bad habits of posture. No patient was taken without prescription and full instructions from his doctor; in the case of patients from the fracture clinic, the occupational therapist in charge attended regularly at the clinic when the orthopedic surgeon was reexamining the patient, and heard his fresh instructions. A report from the hospital social service department was also received on each case. Treatment was given only in the mornings, but the whole day should be occupied if possible before the patient is discharged back to work.

These cases bring out the importance of the muscular spasm which often develops before treatment is begun. Without occupational therapy this is difficult to overcome because the patient has allowed the wrong posture to become a habit. Occupational therapy replaces in the patient's mind the image of a limb that he cannot use by one of a piece of work which that limb is accomplishing. Much depends on the atmosphere into which the new patient is introduced. Allendale was essentially a happy place where people felt they would get well. Each patient was welcomed and made to feel that his difficulties and disabilities were understood. His primitive impulses to investigate new surroundings, to show what he could perform, and to join in the activities of a group, all had to be stimulated; and when the appropriate emotion had been aroused the impulse was directed at once into an activity that helped his recovery. His fear and suspicion had to be circumvented. It usually took a few days to start a patient off well; many grasped the idea of what was intended in the first few minutes and became real enthusiasts in helping newcomers, but others needed much care to begin with; but once they realized that a change had begun in the injured limb, their cooperation could be relied upon.

Experience has taught the following rules: (1) the craft chosen must provide the exact muscle movement needed at each stage. It must be changed as the patient changes; (2) the occupational therapist must superintend the movements continually; she must, therefore, have a complete training in anatomy and physiology, such as is required for massage; (3) the patient's mind must be concentrated on the accomplishment of the work on which he is engaged. Therefore it must be something that he enjoys doing and knows to be useful; and (4) the degree of strenuousness must be regulated. Premature use of heavy tools can only do harm; and to continue light work

too long may produce a dilettante habit, and delay a man's return to his work. The equipment must, therefore, include apparatus for heavy sawing and hammering. Work should be increased until the patient is doing a full day's activity, which can include digging in the garden and prevocation work. Games are a valuable adjunct. A patient who thought he could not play billiards was seen to be acting as marker to the players; he walked round and lifted his arm to mark, unconsciously exceeding what he believed to be his capacity.

Observations On the Relation of Histamine to Reactive Hyperemia. A. Kwiatakowski.

J. Physiol. 100:147 (Sept.) 1941.

Lewis (1927) made extensive studies on reactive hyperemia and concluded that this phenomenon is caused by a vasodilator substance which accumulates in the tissue spaces of a limb when its circulation is obstructed. He suggested that the responsible agent ('H-substance') is a normal metabolite and is similar to histamine.

A new technic is described for the assay of small amounts of histamine. The nature of the alcohol-insoluble substance in blood which contracts smooth muscle was investigated, and was identified as potassium. The histamine content of venous blood in man and the rabbit during a state of reactive hyperemia was not significantly above the normal level. The administration of cysteine annulled the action of injected histamine on the cat's blood pressure, but did not modify the fall of blood pressure which follows reactive hyperemia.

Thermal Sensation and Discrimination in Relation to Intensity of Stimulus. C. M. Herget; L. P. Granath, and J. D. Hardy.

Am. J. Physiol. 134:645 (Oct. 1) 1941.

The object of this report is to present new data on the relationship of the intensity of a thermal stimulus to (1) the intensity of the sensory response, and (2) the discriminatory ability for temperature sensation.

In the present work there is employed a modification of the technics of radiation used formerly in the laboratory of the Russell Sage Institute of Pathology. This modification is especially well suited to this type of problem. The methods described use exclusively radiation as the stimulating agent, a procedure to which decided advantages accrue. In this procedure any actual material contact between subject and stimulator is avoided obviating thereby the arousal of unwanted sensations such as touch.

Warmth Sense in Relation to the Area of Skin Stimulated. C. M. Herget; L. P. Granath, and J. D. Hardy.

Am. J. Physiol. 135:20 (Dec. 1) 1941.

It has been shown that, within certain limits, the larger the area of skin exposed to a thermal stimulus, the lower is the intensity of stimulus necessary to evoke a sensation. This inverse relation between warmth threshold and area of skin exposed, which is a manifestation of spatial summation, has its counterpart in vision as established by Granit and Harper and the recent experiments of Hartline. It must be pointed out that while the previous work on warmth sensation concerned itself with thresholds, the reports of Jenkins indicate that the summation of super-liminal sensations does not follow the same summation law as does threshold sensation. This presents three possible relations between sensation and size of the stimulated area: 1, a large sensation might be built up from a number of smaller ones by summation of the nerve impulses from several fibers; 2, the skin might become more sensitive as the result of addition of numbers of stimuli below the sensory threshold, that is, the threshold would be lowered; 3, both 1 and 2 might obtain. Possibilities 1 and 2 are not mutually inclusive, and although Hardy and Oppel have established the second, the recent work of Jenkins would deny the first. It is the object of this paper to present data which give a further analysis of the phenomenon of spatial summation of warmth establishing the summation of super-liminal stimuli on the same basis as sub-threshold stimuli.

Further evidence of the reliability of the flicker method of studying temperature sensation has been outlined. Two types of spatial summation for warmth have been found. One occurs peripherally, probably between branches of a single fiber; the other occurs centrally, between different fibers. The second type of summation is not the result of a lowered synaptic resistance. One fiber and its branches seems to serve about 3 to 5 sq. cm. of the forehead. Areal discrimination of warmth is relatively poor at areas less than about 3 sq. cm. and is a rapidly changing function of area. For areas larger than 3 sq. cm., the relative discrimination is better and is practically constant. A general expression for sensory response in terms of the threshold sensation has been obtained for the forehead for areas larger than 3 sq. cm. and intensities below 1,000 units. Super-liminal sensations are found to obey the same law as the threshold sensation.

